

CR135172

A Method to Estimate Weight and Dimensions of Aircraft Gas Turbine Engines

Final Report

Volume III: Programmer's Manual

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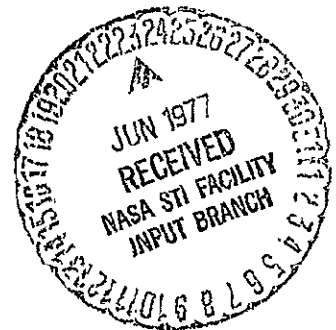
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15 Supplementary Notes Final Report (see also NASA CR135170 Method of Analysis and CR135171, User's Manual) Program Manager, Laurence Fishbach, Wind Tunnel and Flight Division, Mission Analysis Branch, NASA Lewis Research Center, Cleveland, Ohio					
16 Abstract A computerized method has been developed to estimate weight and envelope dimensions of aircraft gas turbine engines within $\pm 5\%$ to 10%. The method is based on correlations of component weight and design features of 29 data base engines. Rotating components are estimated by a preliminary design procedure where blade geometry, operating conditions, material properties, shaft speed, hub-tip ratio, etc., are the primary independent variables used. The development and justification of the method selected, the various methods of analysis, the use of the program, and a description of the input-output data are discussed in this report.					
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A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS OF
AIRCRAFT GAS TURBINE ENGINES

Vol III -- Programmers Manual

By R. J. Pera, E. Onat, N. L. Prewitt, G. W. Klees, E. Tjonneland

1.0 SUMMARY

The purpose of this volume is to aid the programmer responsible for maintaining the computer code for weight estimating (WATE-1). A User's Manual (CR135171) and Method of Analysis (CR135170) are also available which describe the operation and use of WATE-1.

Included in this volume are program checkout cases in Appendix A starting on Pg. A1 and Fortran Listings in Appendix B, starting with Pg. B1. An Index of material contained in each appendix is given on Pg. A1 and B1.

The code is in FORTRAN IV and has been checked out on IBM 370/168. The code is single precision except for the values in the Navy-NASA Engine program (NNEP). The code was designed to minimize conversion requirements to other machines.

- 1 no subroutines are required beyond those in the IBM FORTRAN IV manual, and
- 2 there is no character manipulation, only full word tests are used when testing BCD input

The NNEP/WATE-1 code requires 75B48₁₆ core (482120₁₀ bytes) to run without buffers. The execution of a design point followed by a weight estimation and printer plot is 4 seconds CPU time, using an existing load module (all data reference 370/168).

2.0 CONVERSION FACTORS

The array CONVER in common CONVER are conversion factors to convert English units to SI units.

ARRAY #	VALUE	UNITS ENGLISH	to	UNITS SI
1	2.54	inch		cm
2	.3048	feet		meter
3	.4536	lb _m		K _g
4	.0929	ft ²		meter ²
5	.02768	lb _m /in ³		K _g /cm ³
6	.689475	lb _f /in ²		Newton/cm ²
7	4.882	lb _m /ft ²		K _g /m ²
8	.555	°R		°K
9	1.05435	BTU/sec		K WATTS
10	.7457	HP		K WATTS
11	47.88	lb _f /ft ²		Newton/m ²

3.0 DISCUSSION

3.1 Program Structure

The execution flow was designed to minimize the interaction of the basic NNEP program and the weight estimation routines. The only data flowing between the two is via the common blocks SNGL and DBL and the variables IWT and IPLT. The subroutine THERM is used to obtain thermodynamic properties of the fluid. An assumption is made that the thermodynamic properties are established at each station prior to calling WTEST subroutine.

Routine WTEST acts as a control routine which calls the component routines. These component routines are independent of each other although some use the same lower level routine as some other component routine. After all weights and dimensions have been estimated routine ENGPLT is called to make the printer plot. For a description of subroutine connectivity, see Figure 1.

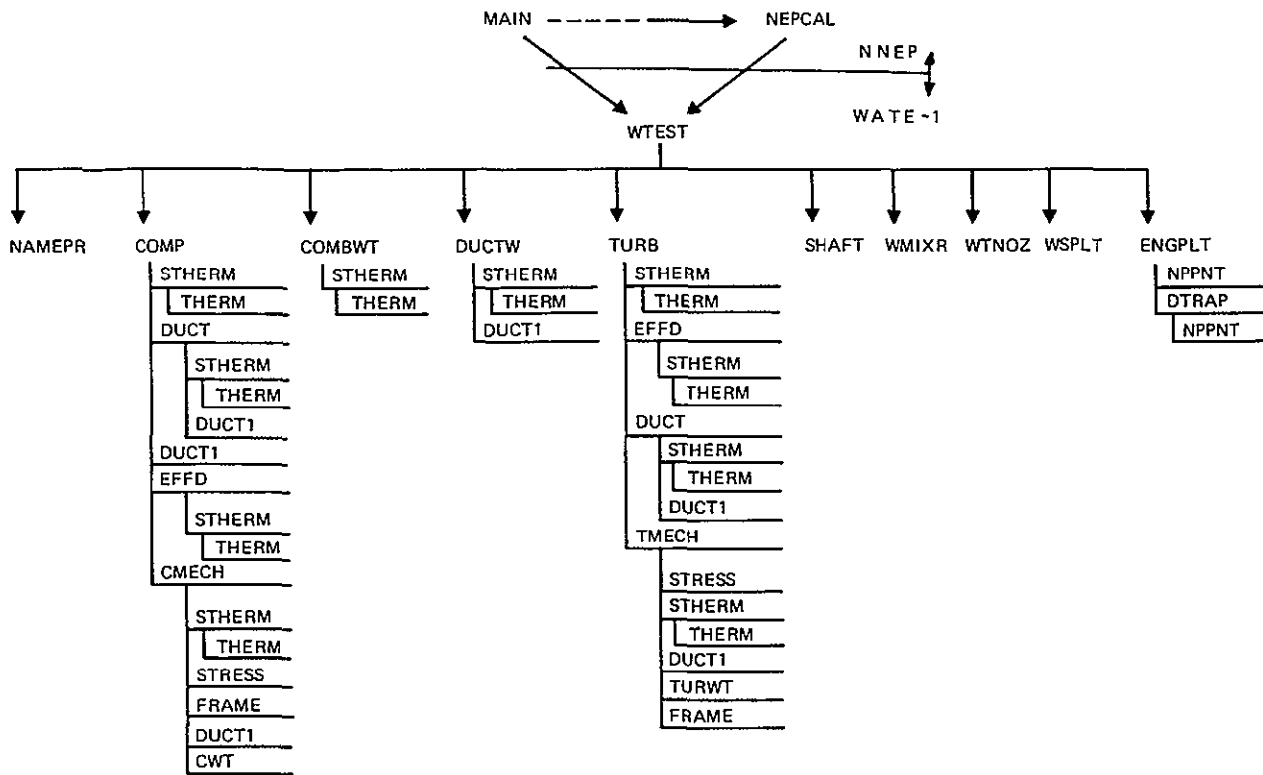


Figure 1 Diagram of Subroutine Connectivity

3.2 Data Flow

The following variables in NNEP common blocks may be referenced by a component weight estimating routine depending on the component type. DATOUT, WTF, TOPRES, TOTEMP, FAR, CORFLO, JCONF, JTYPE, NCOMP, NOSTAT, NFINIS. In no case is any value changed by the weight estimation code. Each call to WTEST routine will cause a NAMELIST read of "W" data (see User's manual). This is the one and only read in weight estimation code. Based on the information in NCOMP and JTYPE the proper component routine is called with the component number (I) as an argument. Each component is expected to fill WATE (I), ALENG (I), TLENG (I), RØ (1,I), RØ (2,I), RI (1,I), RI (2,I). Rotating components also fill RPMT (I). The shaft component fills DSHAFT (N) where N is the shaft count from the inside out. The meaning of these variables is covered in the User's Manual.

3.3 Program Checkout

The concept for program testing is to use one definition through NNEP and then vary the weight data so as to execute all the subtypes of components. In the case of rotating/fixed splitters, these were tested using a namelist read program instead of NNEP to fill the common blocks. The checkout results are shown in Appendix A.

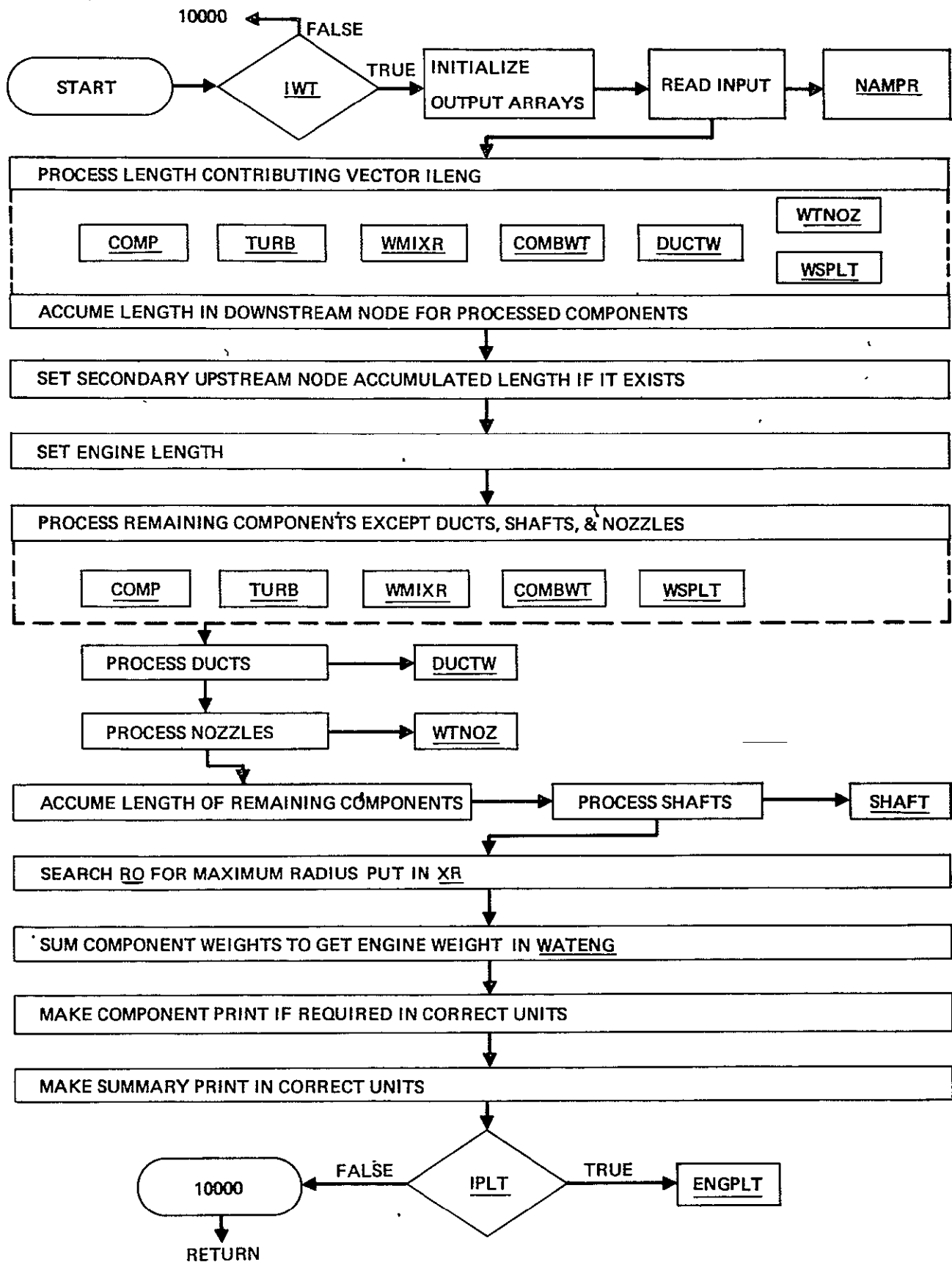


Figure 2 Functional Flow Chart of WTEST

APPENDIX A – Results of Program Checkout

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REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

```

&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

```

THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL

CONFIGURATION DATA 15 STATIONS 21 COMPONENTS

COMPONENT NUMBER	NKIND	COMPONENT TYPE	UPSTREAM STATIONS	DOWNSTREAM STATIONS
---------------------	-------	-------------------	----------------------	------------------------

1	1	INLET	1	0	2	.0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14	VARY DATINP	1 OF COMPONENT	8 SO THAT STATP	8 OF FLOW STATION	13 EQUALS	0.0
15	VARY DATINP	1 OF COMPONENT	7 SO THAT STATP	8 OF FLOW STATION	9 EQUALS	0.0
16	VARY DATINP	1 OF COMPONENT	5 SO THAT STATP	8 OF FLOW STATION	8 EQUALS	0.0
17	VARY DATINP	1 OF COMPONENT	3 SO THAT DATOUT	8 OF COMPONENT	9 EQUALS	0.0
18	VARY DATINP	1 OF COMPONENT	2 SO THAT STATP	8 OF FLOW STATION	5 EQUALS	0.0
19	VARY DATINP	1 OF COMPONENT	1 SO THAT STATP	8 OF FLOW STATION	2 EQUALS	0.0
20	VARY DATINP	1 OF COMPONENT	12 SO THAT DATOUT	8 OF COMPONENT	12 EQUALS	0.0
21	VARY DATINP	1 OF COMPONENT	13 SO THAT DATOUT	8 OF COMPONENT	13 EQUALS	0.0

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

MODE 1 NOW BEING USED

&W

IPLT=T,

ISII=F,

ISIO=T,

IDUTCD=2,

I LENG(1)=2,3,5,6,7,8,9,10,11,

IWMEC(1,2)='FAN ',1,1,4,3*0,

IWMEC(1,3)='SPLT',6*0,

IWMEC(1,4)='DUCT',3,5*0,

IWMEC(1,5)='HPC ',1,2,4*0,

IWMEC(1,6)='PBUR',1,5*0,

IWMEC(1,7)='HPT ',0,5,-5,3*0,

IWMEC(1,8)='LPT ',1,2,7,3*0,

IWMEC(1,9)='MIX ',6*0,

IWMEC(1,10)='AUG ',6*0,

IWMEC(1,11)='NOZ ',2,-10,4*0,

IWMEC(1,12)='SHAF',1,8,3*0,2,

IWMEC(1,13)='SHAF',2,7,3*0,5,

DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,

DESVAL(1,3)=15*0.,

DESVAL(1,4)=.45,2*0.,11.,11*0.,

DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,

DESVAL(1,6)=100.,.015,0.,5.,11*0.,

DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,6*0.,

DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,6*0.,

DESVAL(1,9)=15*0.,

DESVAL(1,10)=250.,.016,13*0.,

DESVAL(1,11)=1.,14*0.,

DESVAL(1,12)=50000.,.3,.85,12*0.,

DESVAL(1,13)=50000.,.3,13*0.,

&END

* *

* FAN 2 *

* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.524	174.	288.	91192.	75626.	0.6458	1.4005

U TIP	STRESS	DEN	W/AREA	TR	H/T
383.7	18448.8	0.005	11.421	1.800	0.450

COMPRESSOR 2 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.874	3.00	101.54	383.7	7216.9	7216.9

FRAME WT = 43.40

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 29.3 26.8 26.8 0.0 12.018.669.00465.00465 3.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4789 17.6 0.524 0.646 22.85 50.77 59 383.7 18449. 95. 288.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 41.1 15.5 15.5 22.9 9.515.697.00465.00465 3.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4155 17.6 0.499 0.481 28.00 48.12 67 363.7 13921. 105. 327.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 43.9 10.4 10.4 21.0 8.414.400.00465.00465 2.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3671 17.6 0.475 0.373 30.92 46.30 70 349.5 10872. 94. 365.

FRAME WT = 129.34

N STG WEIGHT LENGTH
 3 466.61 73.15

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 177. 404. 260810. 227078. 0.2992 1.3951

PR AD EF PO TO HP
 2.8600 0.8700260809.8 403.8 1261.
 HI HO WI CWI
 130.69 183.53 108.18 120.20

***** TOTAL COMP WEIGHT IS 466.609

 * *
 * HPC 5 *
 * *
 *****2

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 177. 404. 260810. 227078. 0.1690 1.3951

U TIP STRESS DEN W/AREA TR H/T
 391.7 16086.6 0.005 3.356 1.200 0.700

COMPRESSOR 5 MECHANICAL DESIGN

LOADING N STG DIAM U TIP C PPM C RPM
 0.651 10.00 64.96 330.9 11515.5 9727.5

FRAME WT = 53.63

STAGE 1

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
10.8	6.5	6.5	16.5	4.711	1.401	0.00465	0.00465	2.00

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.3603	18.8	0.450	0.169	22.74	32.48	50	391.7	16087.	45.	404.				

STAGE 2

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
9.0	4.0	4.0	13.4	3.7	9.241	0.00465	0.00465	1.94

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.3241	18.8	0.435	0.134	23.93	31.61	60	381.2	12767.	34.	445.				

STAGE 3

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
7.3	2.6	2.6	11.1	3.0	7.699	0.00465	0.00465	1.89

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2948	18.8	0.420	0.109	24.76	30.97	70	373.5	10375.	27.	485.				

STAGE 4

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
6.1	2.0	2.0	9.5	2.5	6.560	0.00465	0.00465	1.83

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2704	18.8	0.405	0.090	25.35	30.49	81	367.7	8603.	22.	525.				

STAGE 5

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
5.2	1.6	1.6	8.2	2.2	5.699	0.00465	0.00465	1.78

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2499	18.8	0.390	0.076	25.79	30.12	93	363.2	7258.	19.	565.				

STAGE 6

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
4.6	1.2	1.2	7.3	1.9	5.033	0.00465	0.00465	1.72

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2324	18.8	0.375	0.065	26.12	29.83	104	359.7	6218.	16.	605.				

STAGE 7

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
4.2	1.0	1.0	6.5	1.7	4.512	0.00465	0.00465	1.67

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2173	18.8	0.360	0.057	26.38	29.60	115	356.9	5398.	14.	644.				

STAGE 8

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
7.3	1.4	1.4	5.9	1.5	4.099	0.00792	0.00792	1.61

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2042	18.8	0.345	0.050	26.59	29.41	126	354.7	8075.	18.	683.				

STAGE 9

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
7.0	1.2	1.2	5.5	1.4	3.771	0.00792	0.00792	1.56

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.1926	18.8	0.330	0.044	26.75	29.26	136	352.9	7176.	16.	721.				

STAGE 10

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
6.8	1.0	1.0	5.1	1.3	3.509	0.00792	0.00792	1.50

PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.1824	18.8	0.315	0.040	26.89	29.14	146	351.4	6442.	15.	760.				

N STG WEIGHT LENGTH

10 279.63 64.60

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.300	166.	798.2453	176.2309	282.	0.0360	1.3539

PR	AD EF	PO	TO	HP
9.4060	0.8700	*****	797.6	2533.
HI	HO	WI	CWI	
183.53	371.37	61.12	28.11	

***** TOTAL COMP WEIGHT IS 279.634

* *
* PBUR 6 *
* *

*****2

BURNER NUMBER 6

RIN	ROUT	LENGTH	MACH	WSPEC		
22.246	32.789	18.000	0.055	22.440		
CAS WT	LIN WT	NOZ WT	INC WT	FRAME	WTOT	
11.0	18.3	8.1	7.5	68.6	113.5	

* *
* HPT 7 *
* *

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DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.500	361.	1456.2207	860.1882	986.	0.0369	1.2968

U TIP	STRESS	DEN	W/AREA	TR	H/T
337.1	6770.3	0.008	1.203	1.000	0.922

TURBINE 7 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA
0.922	2.000	0.280	0.037

UT	RTIP	RHUB	DEL H	RPM	TORQ
337.1	28.0	184.0	11515.5	25703.8	

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR
2.91	1.04	3.83	9.85	1.81	1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.8453	92.0	0.500	0.037	25.77	27.96	180	337.1	6770.	19.43	5.12

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR
4.88	2.91	10.75	16.09	3.10	1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
2.0063	92.0	0.525	0.062	25.77	29.34	116	353.8	11346.	37.73	8.37

N STG LENGTH WEIGHT

2 13.49 57.17

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	350.	1127.	595416.	490421.	0.1122	1.3127

PR	TR	AD EF	PO	TO	TO.1
3.7081	1.2928	0.86005954	15.9	1126.5	1126.5
H IN	H OUT	AREA	FLOW	HP	
737.29	553.26	0.48	62.40	2533.	

***** TOTAL TURB WEIGHT IS 57.166

*
* LPT 8 *
*
*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	350.	1127.	595538.	490523.	0.1122	1.3127

U TIP	STRESS	DEN	W/AREA	TR	H/T
221.6	8072.8	0.008	3.793	1.000	0.765

TURBINE 8 MECHANICAL DESIGN					
H/T	N STG	LOADING	AREA		
0.765	2.000	0.243	0.112		
UT	RTIP	RHUB	DEL H	RPM	TORQ
221.6	29.3	91.6	7216.9	20419.6	

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR						
2.29	10.14	29.95	17.63	4.49	2.00						
PP	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
1.4669	45.8	0.550	0.112	22.42	29.32	80	221.6	8073.	64.49	12.11	

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR						
3.13	12.50	36.93	15.43	4.22	3.00						
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
1.5156	45.8	0.575	0.153	22.42	31.48	98	237.9	11045.	72.22	10.60	

FRAME WT = 76.11

N STG	LENGTH	WEIGHT
2	34.06	212.82

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.600	352.	956.	267825.	212419.	0.2166	1.3249

PR	TR	AD EF	PO	TO	TO.1
2.2236	1.1779	0.86002678	24.9	956.4	956.4
H IN	H OUT	AREA	FLOW	HP	
553.29	461.67	1.56	62.40	1261.	

***** TOTAL TURB WEIGHT IS 212.822

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* AUG 10 *

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*****2

BURNER NUMBER 10

RIN	ROUT	LENGTH	MACH	WSPEC
0.0	61.264	48.000	0.143	58.089

CAS WT	LIN WT	NOZ WT	INC WT	FRAME	WTOT
10.8	54.4	134.3	0.0	199.5	

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* NOZ 11 *

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NOZZLE 11

WEIGHT= 258.07 LENGTH= 122.528 TR WT= 0.0

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* DUCT 4 *

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DUCT , 4

RH= 40.0708 RT= 44.9444 LENG=157.8737

AREA= 0.1302 RHO=.0046504

OUTER CASE= 7.0493 INNER CASE= 6.2849 TOTAL=13.3342

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* SHAF 12 *

* *

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SHAFT 12

DO	DI	LENG	DN	WT
9.00	7.65	123.81	0.65	18.16

* *

* SHAF 13 *

* *

*****2

SHAFT 13

DO	DI	LENG	DN	WT
11.05	10.02	45.72	1.27	6.50

* *

* ACCS WT *

* *

*****2

ACCS WT= 136.721

WEIGHT INPUT DATA IN ENGL UNITS
 WEIGHT OUTPUT DATA IN SIU UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS				DOWNSTREAM RADIUS				NSTAGE
				RI	RO	RI	RO	RI	RO	RI	RO	
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	467.	73.	73.	23.	51.	0.	0.	33.	45.	0.	0.	3
3	0.	0.	73.	0.	0.	0.	0.	33.	40.	40.	45.	0
4	13.	158.	231.	40.	45.	0.	0.	40.	45.	0.	0.	0
5	280.	65.	138.	23.	32.	0.	0.	27.	29.	0.	0.	10
6	113.	46.	183.	22.	33.	0.	0.	22.	33.	0.	0.	0
7	57.	13.	197.	26.	28.	0.	0.	26.	32.	0.	0.	2
8	213.	34.	231.	22.	29.	0.	0.	22.	35.	0.	0.	2
9	0.	0.	231.	11.	40.	40.	54.	11.	54.	0.	0.	0
10	199.	122.	353.	0.	61.	0.	0.	0.	61.	0.	0.	0
11	258.	123.	475.	0.	61.	0.	0.	0.	56.	0.	0.	0
12	18.	0.	0.	23.	51.	26.	28.	0.	0.	0.	0.	0
13	7.	0.	0.	23.	32.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 1625. ACCESSORIES= 136.72

ESTIMATED TOTAL LENGTH= 475. ESTIMATED MAXIMUM RADIUS= 61.

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO. TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2 COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3 SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6 DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7 TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8 TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9 MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10 DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12 SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0

13 SHAFT 0.0 0.60000D 04 0.60000D 04 0.60000D 04 0.0 0.0 0.0 0.0 0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

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&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END
```

THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL

CONFIGURATION DATA		15 STATIONS	21 COMPONENTS
COMPONENT NUMBER	NKIND COMPONENT TYPE	UPSTREAM STATIONS	DOWNSTREAM STATIONS

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14	VARY DATINP	1 OF COMPONENT	8 SO THAT STATP	8 OF FLOW STATION	13 EQUALS	0.0
15	VARY DATINP	1 OF COMPONENT	7 SO THAT STATP	8 OF FLOW STATION	9 EQUALS	0.0
16	VARY DATINP	1 OF COMPONENT	5 SO THAT STATP	8 OF FLOW STATION	8 EQUALS	0.0
17	VARY DATINP	1 OF COMPONENT	3 SO THAT DATOUT	8 OF COMPONENT	9 EQUALS	0.0
18	VARY DATINP	1 OF COMPONENT	2 SO THAT STATP	8 OF FLOW STATION	5 EQUALS	0.0
19	VARY DATINP	1 OF COMPONENT	1 SO THAT STATP	8 OF FLOW STATION	2 EQUALS	0.0
20	VARY DATINP	1 OF COMPONENT	12 SO THAT DATOUT	8 OF COMPONENT	12 EQUALS	0.0
21	VARY DATINP	1 OF COMPONENT	13 SO THAT DATOUT	8 OF COMPONENT	13 EQUALS	0.0

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```

MODE      1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='AUG ',6*0,
IWMEC(1,11)='NOZ ',2,-10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
&END

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*  FAN    2  *
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*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	596.	519.	1905.	1551.	6.7289	1.4005

U TIP	STRESS	DEN	W/AREA	TR	H/T
1258.9	26757.6	0.168	2.302	1.800	0.450

COMPRESSOR 2 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.874	3.00	39.33	1258.9	7335.4	7335.4

FRAME WT = 92.60

STAGE 1

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
62.	50.	50.	0.	22.	6.3	0.168	0.168	4.00		
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	TIN
1.4789	16.7	0.550	6.729	8.85	19.67	68	1258.9	26758.	184.	519.

STAGE 2

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
86.	29.	29.	42.	18.	5.3	0.168	0.168	3.50		
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	TIN
1.4155	16.7	0.517	5.057	10.80	18.67	78	1194.9	20358.	203.	588.

STAGE 3

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
92.	19.	19.	38.	15.	4.7	0.168	0.168	3.00		
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	TIN
1.3671	16.7	0.483	3.964	11.90	17.98	83	1151.1	16067.	184.	658.

FRAME WT = 278.15

N STG WEIGHT LENGTH
3 940.48 24.49

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.450	582.	727.	5447.	4743.	3.2206	1.3951

PR	AD EF	PO	TO	HP
2.8600	0.8700	5447.2	726.9	16910.
HI	HO	WI	CWI	
123.95	174.07	238.50	265.00	

***** TOTAL COMP WEIGHT IS 940.481

* *
* HPC 5 *
* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.400	520.	727.	5447.	4880.	1.9973	1.3951

U TIP	STRESS	DEN	W/AREA	TR	H/T
1355.1	25943.6	0.168	0.720	1.200	0.700

COMPRESSOR 5 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.650	9.00	26.80	1144.7	11590.1	9790.5

FRAME WT = 129.77

STAGE 1

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
32.	14.	14.	28.	8.	3.1	0.168	0.168	3.00		
PR	DEL H	MACH	AREA	R	HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.4051	19.8	0.400	1.997	9.38	13.40	94	1355.1	25944.	95.	727.

STAGE 2

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
27.	8.	8.	23.	6.	2.6	0.168	0.168	2.81		
PR	DEL H	MACH	AREA	R	HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.3600	19.8	0.389	1.536	9.93	13.00	112	1314.6	19975.	72.	808.

STAGE 3

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
21.	6.	6.	19.	5.	2.2	0.168	0.168	2.63		
PR	DEL H	MACH	AREA	R	HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.3243	19.8	0.378	1.215	10.29	12.71	129	1285.7	15816.	56.	889.

STAGE 4

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR		
17.	4.	4.	17.	4.	1.9	0.168	0.168	2.44		
PR	DEL H	MACH	AREA	R	HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2951	19.8	0.367	0.984	10.54	12.50	146	1264.4	12815.	46.	970.

STAGE 5
 WD WB WS WN WC CL RHOB RHOD AR
 14. 3. 3. 15. 4. 1.7 0.168 0.168 2.25
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2709 19.8 0.356 0.812 10.73 12.34 162 1248.4 10588. 39. 1049.

STAGE 6
 WD WB WS WN WC CL RHOB RHOD AR
 12. 3. 3. 14. 3. 1.5 0.168 0.168 2.06
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2506 19.8 0.344 0.682 10.87 12.22 175 1236.1 8895. 34. 1128.

STAGE 7
 WD WB WS WN WC CL RHOB RHOD AR
 20. 4. 4. 13. 3. 1.4 0.286 0.286 1.88
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2333 19.8 0.333 0.581 10.97 12.13 185 1226.5 12905. 43. 1206.

STAGE 8
 WD WB WS WN WC CL RHOB RHOD AR
 18. 3. 3. 12. 3. 1.4 0.286 0.286 1.69
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2183 19.8 0.322 0.502 11.06 12.05 192 1218.9 11139. 40. 1283.

STAGE 9
 WD WB WS WN WC CL RHOB RHOD AR
 17. 3. 3. 12. 3. 1.4 0.286 0.286 1.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2053 19.8 0.311 0.438 11.12 11.99 195 1212.8 9726. 38. 1360.

N STG WEIGHT LENGTH
 9 593.11 18.07

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.300 544. 1436. 51236. 48231. 0.3874 1.3539

PR AD EF PO TO HP
 9.4060 0.8700 51235.9 1435.6 33965.
 HI HO WI CWI
 174.07 352.23 134.75 61.97

***** TOTAL COMP WEIGHT IS 593.109

 * *
 * PBUR 6 *
 * *
 *****2

BURNER NUMBER 6
 RIN ROUT LENGTH MACH WSPEC
 9.414 13.363 18.000 0.055 4.596
 CAS WT LIN WT NOZ WT INC WT FRAME WTOT
 26.0 42.5 17.9 18.3 162.2 266.8

*
* HPT 7 *
*

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.300	720.	2621.	46112.	43515.	0.6059	1.2968

U TIP	STRESS	DEN	W/AREA	TR	H/T
1045.1	15157.4	0.286	0.413	1.000	0.860

TURBINE 7 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA
0.860	2.000	0.250	0.606

UT	RTIP	RHUB	DEL H	RPM	TORQ
1045.1	10.3	8.9	174.5	11590.1	184717.

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR
8.0	6.0	22.3	27.9	6.3	1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.8453	87.3	0.300	0.606	8.89	10.33	101	1045.1	15157.	70.58	3.38

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR
10.2	12.7	46.7	37.0	9.2	1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
2.0063	87.3	0.375	0.865	8.55	10.62	72	1073.8	21644.	115.79	4.84

N STG	LENGTH	WEIGHT
2	8.22	186.37

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.450	947.	2028.	12436.	10910.	1.3959	1.3127

PR	TR	AD EF	PO	TO	TO.1
3.7081	1.2928	0.8600	12435.6	2027.7	2027.7
H IN	H OUT	AREA	FLOW	HP	
699.28	524.74	5.17	137.56	33969.	

***** TOTAL TURB WEIGHT IS 186.369

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*           *
*  LPT    8  *
*           *
*****2

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DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.450	947.	2028.	12438.	10913.	1.3957	1.3127

U TIP	STRESS	DEN	W/AREA	TR	H/T
602.1	13984.5	0.286	1.275	1.000	0.526

TURBINE 8 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA
0.526	3.000	0.250	1.396

UT	RTIP	RHUB	DEL H	RPM	TORQ
602.1	9.4	4.9	86.9	7335.4	145306.

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR
1.3	48.1	142.1	20.0	13.2	2.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.2867	29.0	0.450	1.396	4.95	9.41	39	602.1	13984.	224.80	7.82

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR
1.0	49.2	145.3	12.3	11.1	3.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.3044	29.0	0.483	1.656	4.30	9.72	50	622.1	16596.	218.77	6.33

STAGE 3

DISK	BLADE	VANE	HWD	CASE	AR
0.5	61.8	182.6	6.7	10.9	4.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.3246	29.0	0.517	2.001	3.26	10.12	55	647.6	20051.	262.58	6.02

FRAME WT = 102.56

N STG	LENGTH	WEIGHT
3	26.90	808.72

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1062.	1722.	5594.	4600.	2.4638	1.3249

PR	TR	AD EF	PO	TO	TO.1
2.2236	1.1779	0.8600	5593.7	1721.5	1721.5

H IN	H OUT	AREA	FLOW	HP
524.77	437.87	16.80	137.56	16912.

***** TOTAL TURB WEIGHT IS 808.718

*
* AUG 10 *
*

*****2

BURNER NUMBER	10			
RIN	ROUT	LENGTH	MACH	WSPEC
0.0	22.068	54.000	0.172	14.214

CAS WT	LIN WT	NOZ WT	INC WT	WTOT
22.3	123.5	278.8	0.0	424.7

*
* NOZ 11 *
*

*****2

NOZZLE 11
WEIGHT= 476.27 LENGTH= 44.136 TR WT= 0.0

*
* DUCT 4 *
*

*****2

DUCT , 4
RH= 16.53 RT= 16.53 LENG= 71.19
AREA= 0.0 RHO=.168
CAS WT INC WT WTOT
15.5346 15.5346 31.0693

*
* SHAF 12 *
*

*****2

SHAFT 12				
DO	DI	LENG	DN	WT
2.76	0.0	44.29	0.51	75.57

*
* SHAF 13 *
*

*****2

SHAFT 13				
DO	DI	LENG	DN	WT
3.76	3.16	18.00	1.11	16.79

*
* ACCS WT *
*

*****2

ACCS WT= 334.358

WEIGHT INPUT DATA IN ENGL UNITS
 WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS				DOWNSTREAM RADIUS				NSTAGE
				RI	RO	RI	RO	RI	RO	RI	RO	
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	940.	24.	24.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	24.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	31.	71.	96.	17.	17.	0.	0.	17.	17.	0.	0.	0
5	593.	18.	43.	9.	13.	0.	0.	11.	12.	0.	0.	9
6	267.	18.	61.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	186.	8.	69.	9.	10.	0.	0.	8.	11.	0.	0.	2
8	809.	27.	96.	5.	9.	0.	0.	0.	11.	0.	0.	3
9	0.	0.	96.	0.	15.	15.	21.	0.	21.	0.	0.	0
10	425.	54.	150.	0.	22.	0.	0.	0.	22.	0.	0.	0
11	476.	44.	194.	0.	22.	0.	0.	0.	20.	0.	0.	0
12	76.	0.	0.	9.	20.	9.	10.	0.	0.	0.	0.	0
13	17.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 3820. ACCESSORIES= 334.36

ESTIMATED TOTAL LENGTH= 194. ESTIMATED MAXIMUM RADIUS= 22.

STATION PROPERTY OUTPUT DATA

FLCH STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE FLOW ERROR STATP8	CORRECTED
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0	
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0	
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0	
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0	
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0	
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0	
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	C.C	
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0	
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	C.0	
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0	
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0	
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	C.0	
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	C.0	
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	C.0	

COMPONENT OUTPUT DATA

COMPONENT AC. TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2 COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D-00	0.28600D 01
3 SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6 DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7 TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8 TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 03	0.22234D 01
9 MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94950D-16	0.10000D 01
10 DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12 SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0

13 SHAFT 0.0 0.60000D 04 0.60000D 04 0.60000D 04 0.0 0.0 0.0 0.0 0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

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&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

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THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL

CONFIGURATION DATA 15 STATIONS 21 COMPONENTS

COMPONENT NUMBER	NKIND	COMPONENT TYPE	UPSTREAM STATIONS		DOWNSTREAM STATIONS	
1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14	VARY DATINP	1 OF COMPONENT	8 SO THAT STATP	8 OF FLOW STATION	13 EQUALS	0.0
15	VARY DATINP	1 OF COMPONENT	7 SO THAT STATP	8 OF FLOW STATION	9 EQUALS	0.0
16	VARY DATINP	1 OF COMPONENT	5 SO THAT STATP	8 OF FLOW STATION	8 EQUALS	0.0
17	VARY DATINP	1 OF COMPONENT	3 SO THAT DATOUT	8 OF COMPONENT	9 EQUALS	0.0
18	VARY DATINP	1 OF COMPONENT	2 SO THAT STATP	8 OF FLOW STATION	5 EQUALS	0.0
19	VARY DATINP	1 OF COMPONENT	1 SO THAT STATP	8 OF FLOW STATION	2 EQUALS	0.0
20	VARY DATINP	1 OF COMPONENT	12 SO THAT DATOUT	8 OF COMPONENT	12 EQUALS	0.0
21	VARY DATINP	1 OF COMPONENT	13 SO THAT DATOUT	8 OF COMPONENT	13 EQUALS	0.0

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT		DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
NO. TYPE										
1 INLET		0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2 COMPRESR		0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3 SPLITTER		0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESR		0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6 DUCT B		0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7 TURBINE		0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8 TURBINE		0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9 MIXER		0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10 DUCT B		0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11 NOZZLE		0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12 SHAFT		0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13 SHAFT		0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21 CONTROL		0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

MODE 1 NOW BEING USED

&W

IPLT=T,

ISII=F,

ISIO=F,

IOUTCD=2,

I LENG(1)=2,3,5,6,7,8,9,10,11,

IWMEC(1,2)='FAN ',1,1,4,3*0,

IWMEC(1,3)='SPLT',6*0,

IWMEC(1,4)='DUCT',3,5*0,

IWMEC(1,5)='HPC ',1,2,4*0,

IWMEC(1,6)='PBUR',1,5*0,

IWMEC(1,7)='HPT ',0,5,-5,3*0,

IWMEC(1,8)='LPT ',1,2,7,3*0,

IWMEC(1,9)='MIX ',6*0,

IWMEC(1,10)='AUG ',6*0,

IWMEC(1,11)='NOZ ',2,-10,4*0,

IWMEC(1,12)='SHAF',1,8,3*0,2,

IWMEC(1,13)='SHAF',2,7,3*0,5,

DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,0,1.1,

DESVAL(1,3)=14*0.,1.1,

DESVAL(1,4)=.45,2*0.,11.,10*0.,1.1,

DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,0,1.1,

DESVAL(1,6)=100.,.015,0.,5.,10*0.,1.1,

DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,5*0.,1.1,

DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,5*0.,1.1,

DESVAL(1,9)=14*0.,1.1,

DESVAL(1,10)=250.,.016,12*0.,1.1,

DESVAL(1,12)=50000.,.3,.85,11*0.,1.1,

DESVAL(1,11)=1.,13*0.,1.1,

DESVAL(1,13)=50000.,.3,12*0.,1.1,

&END

* *

* FAN 2 *

* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.524	570.	519.	1905.	1579.	6.9517	1.4005

U TIP	STRESS	DEN	W/AREA	TR	H/T
1258.9	26757.6	0.168	2.339	1.800	0.450

COMPRESSOR 2 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.874	3.00	39.98	1258.9	7216.9	7216.9

FRAME WT = 95.67

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 65. 59. 59. 0. 26. 7.4 0.168 0.168 3.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4789 16.7 0.524 6.952 8.99 19.99 59 1258.9 26758. 209. 519.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 91. 34. 34. 51. 21. 6.2 0.168 0.168 3.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4155 16.7 0.499 5.180 11.02 18.95 67 1193.2 20191. 231. 588.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 97. 23. 23. 46. 19. 5.7 0.168 0.168 2.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3671 16.7 0.475 4.017 12.17 18.23 70 1148.1 15768. 208. 658.

FRAME WT = 285.15

N STG WEIGHT LENGTH
 3 1028.68 28.80

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 3.2206 1.3951

PR AD EF PO TO HP
 2.8600 0.8700 5447.2 726.9 16910.
 HI HO WI CWI
 123.95 174.07 238.50 265.00

***** TOTAL COMP WEIGHT IS 1028.680

 * *
 * HPC 5 *
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 *****2

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 1.8196 1.3951

U TIP STRESS DEN W/AREA TR H/T
 1285.1 23331.5 0.168 0.687 1.200 0.700

COMPRESSOR 5 MECHANICAL DESIGN

LOADING N STG DIAM U TIP C RPM C RPM
 0.651 10.00 25.58 1085.6 11515.5 9727.5

FRAME WT = 118.22

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 24. 14. 14. 36. 10. 4.5 0.168 0.168 2.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3603 17.8 0.450 1.820 8.95 12.79 50 1285.1 23331. 99. 727.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 20. 9. 9. 29. 8. 3.6 0.168 0.168 1.94
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3241 17.8 0.435 1.442 9.42 12.45 60 1250.7 18516. 75. 800.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 16. 6. 6. 25. 7. 3.0 0.168 0.168 1.89
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2948 17.8 0.420 1.171 9.75 12.19 70 1225.3 15048. 59. 873.

STAGE 4
 WD WB WS WN WC CL RHOB RHOD AR
 13. 4. 4. 21. 6. 2.6 0.168 0.168 1.83
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2704 17.8 0.405 0.970 9.98 12.00 81 1206.2 12477. 49. 946.

STAGE 5
 WD WB WS WN WC CL RHOB RHOD AR
 11. 3. 3. 18. 5. 2.2 0.168 0.168 1.78
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2499 17.8 0.390 0.818 10.15 11.86 93 1191.5 10527. 41. 1017.

STAGE 6
 WD WB WS WN WC CL RHOB RHOD AR
 10. 3. 3. 16. 4. 2.0 0.168 0.168 1.72
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2324 17.8 0.375 0.701 10.28 11.74 104 1180.1 9018. 36. 1089.

STAGE 7
 WD WB WS WN WC CL RHOB RHOD AR
 9. 2. 2. 14. 4. 1.8 0.168 0.168 1.67
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2173 17.8 0.360 0.608 10.39 11.65 115 1171.0 7829. 32. 1159.

STAGE 8
 WD WB WS WN WC CL RHOB RHOD AR
 16. 3. 3. 13. 3. 1.6 0.286 0.286 1.61
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2042 17.8 0.345 0.534 10.47 11.58 126 1163.6 11712. 39. 1229.

STAGE 9
 WD WB WS WN WC CL RHOB RHOD AR
 15. 3. 3. 12. 3. 1.5 0.286 0.286 1.56
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.1926 17.8 0.330 0.475 10.53 11.52 136 1157.7 10407. 36. 1299.

STAGE 10
 WD WB WS WN WC CL RHOB RHOD AR
 15. 2. 2. 11. 3. 1.4 0.286 0.286 1.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.1824 17.8 0.315 0.426 10.59 11.47 146 1152.8 9343. 33. 1367.

N STG WEIGHT LENGTH
 10 616.48 25.43

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.300	544.	1436.	51236.	48231.	0.3874	1.3539

PR	AD EF	PO	TO	HP
9.4060	0.8700	51235.9	1435.6	33965.
HI	HO	WI	CWI	
174.07	352.23	134.75	61.97	

***** TOTAL COMP WEIGHT IS 616.477

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* PBUR 6 *
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BURNER NUMBER 6

RIN	ROUT	LENGTH	MACH	WSPEC		
8.758	12.909	18.000	0.055	4.596		
CAS WT	LIN WT	NOZ WT	INC WT	FRAME	WTOT	
24.2	40.4	17.8	16.4	151.3	250.2	

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* HPT 7 *
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DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.500	1186.	2621.	46112.	39327.	0.3977	1.2968

U TIP	STRESS	DEN	W/AREA	TR	H/T
1106.0	9819.5	0.286	0.246	1.000	0.922

TURBINE 7 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA			
0.922	2.000	0.280	0.398			
UT	RTIP	RHUB	DEL H	RPM	TORQ	
1106.0	11.0	10.1	174.5	11515.5	185913.	

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR						
6.4	2.3	8.4	21.7	4.0	1.50						
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
1.8453	87.3	0.500	0.398	10.14	11.01	180	1106.0	9820.	42.84	2.02	

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR						
10.8	6.4	23.7	35.5	6.8	1.50						
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
2.0063	87.3	0.525	0.666	10.14	11.55	116	1160.9	16456.	83.19	3.29	

N STG	LENGTH	WEIGHT
2	5.31	126.03

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1149.	2028.	12436.	10243.	1.2074	1.3127

PR	TR	AD EF	PO	TO	TO.1
3.7081	1.2928	0.8600	12435.6	2027.7	2027.7
H IN	H OUT	AREA	FLOW	HP	
699.28	524.74	5.17	137.56	33969.	

***** TOTAL TURB WEIGHT IS 126.028.

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* LPT 8 *
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DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1149.	2028.	12438.	10245.	1.2072	1.3127

U TIP	STRESS	DEN	W/AREA	TR	H/T
727.0	11708.5	0.286	0.777	1.000	0.765

TURBINE 8 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA			
0.765	2.000	0.243	1.207			
UT	RTIP	RHUB	DEL H	RPM	TORQ	
727.0	11.5	8.8	86.9	7216.9	147693.	

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR								
5.0	22.4	66.0	38.9	9.9	2.00								
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH			
1.4669	43.4	0.550	1.207	8.83	11.54	80	727.0	11709.	142.18	4.77			

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR								
6.9	27.6	81.4	34.0	9.3	3.00								
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH			
1.5156	43.4	0.575	1.652	8.83	12.39	98	780.6	16019.	159.21	4.17			

FRAME WT = 167.79

N STG	LENGTH	WEIGHT
2	13.41	469.18

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.600	1154.	1722.	5594.	4436.	2.3313	1.3249

PR	TR	AD EF	PO	TO	TO.1
2.2236	1.1779	0.8600	5593.7	1721.5	1721.5
H IN	H OUT	AREA	FLOW	HP	
524.77	437.87	16.80	137.56	16912.	

***** TOTAL TURB WEIGHT IS 469.184

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* AUG 10 *

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BURNER NUMBER 10

RIN	ROUT	LENGTH	MACH	WSPEC
0.0	24.120	48.000	0.143	11.899
CAS WT	LIN WT	NOZ WT	INC WT	WTOT
23.7	120.0	296.1	0.0	439.8

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* NOZ 11 *

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*****2

NOZZLE 11

WEIGHT= 568.95 LENGTH= 48.239 TR WT= 0.0

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* DUCT 4 *

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*****2

DUCT , 4

RH= 15.78 RT= 17.69 LENG= 62.16

AREA= 1.401 RHO=.168

CAS WT	INC WT	WTOT
15.5408	13.8556	29.3964

* *

* SHAF 12 *

* *

*****2

SHAFT 12

DO	DI	LENG	DN	WT
3.54	3.01	48.74	0.65	40.03

* *

* SHAF 13 *

* *

*****2

SHAFT 13

DO	DI	LENG	DN	WT
4.35	3.94	18.00	1.27	14.33

* *

* ACCS WT *

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*****2

ACCS WT= 301.414

A-34

WEIGHT INPUT DATA IN ENGL UNITS
 WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS				DOWNSTREAM RADIUS				NSTAGE
				RI	RO	RI	RO	RI	RO	RI	RO	
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	1132.	29.	29.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	29.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	32.	62.	91.	16.	18.	0.	0.	16.	18.	0.	0.	0
5	678.	25.	54.	9.	13.	0.	0.	11.	11.	0.	0.	10
6	275.	18.	72.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	139.	5.	78.	10.	11.	0.	0.	10.	13.	0.	0.	2
8	516.	13.	91.	9.	12.	0.	0.	9.	14.	0.	0.	2
9	0.	0.	91.	4.	16.	16.	21.	4.	21.	0.	0.	0
10	484.	48.	139.	0.	24.	0.	0.	0.	24.	0.	0.	0
11	626.	48.	187.	0.	24.	0.	0.	0.	22.	0.	0.	0
12	44.	0.	0.	9.	20.	10.	11.	0.	0.	0.	0.	0
13	16.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 3941. ACCESSORIES= 301.41

ESTIMATED TOTAL LENGTH= 187. ESTIMATED MAXIMUM RADIUS= 24.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

CCMPONENT

[illegible]

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO. TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2 COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3 SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6 DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7 TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8 TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9 MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10 DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12 SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0

13 SHAFT 0.0 0.60000D 04 0.60000D 04 0.60000D 04 0.0 0.0 0.0 0.0 0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPIILLAGE + LIP DRAG	0.0

SIMPLE MODEL
 &D LONG=F, DRAW=F, BOAT=T, SPILL=T, AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

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&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

```

THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL

CONFIGURATION DATA 15 STATIONS 21 COMPONENTS

COMPONENT NUMBER	NKIND	COMPONENT TYPE	UPSTREAM STATIONS	DOWNSTREAM STATIONS
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1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14	VARY DATINP	1 OF COMPONENT	8 SO THAT STATP	8 OF FLOW STATION	13 EQUALS	0.0
15	VARY DATINP	1 OF COMPONENT	7 SO THAT STATP	8 OF FLOW STATION	9 EQUALS	0.0
16	VARY DATINP	1 OF COMPONENT	5 SO THAT STATP	8 OF FLOW STATION	8 EQUALS	0.0
17	VARY DATINP	1 OF COMPONENT	3 SO THAT DATOUT	8 OF COMPONENT	9 EQUALS	0.0
18	VARY DATINP	1 OF COMPONENT	2 SO THAT STATP	8 OF FLOW STATION	5 EQUALS	0.0
19	VARY DATINP	1 OF COMPONENT	1 SO THAT STATP	8 OF FLOW STATION	2 EQUALS	0.0
20	VARY DATINP	1 OF COMPONENT	12 SO THAT DATOUT	8 OF COMPONENT	12 EQUALS	0.0
21	VARY DATINP	1 OF COMPONENT	13 SO THAT DATOUT	8 OF COMPONENT	13 EQUALS	0.0

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610C 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```

MODE      1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',0,2,4,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,0,0,
IWMEC(1,6)='PBUR',0,5*0,
IWMEC(1,7)='HPT ',0,5, 0,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='FMIX',6*0,
IWMEC(1,10)='DBUR',6*0,
IWMEC(1,11)='NOZ ',1,5*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.1,.1,1.,1.,0.,0.,
DESVAL(1,3)=15*0.,
DESVAL(1,4)=.45,2*0.,-1.,11*0.,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,900.,1400.,1.,0.,3.,1.1,1200.,0.,
DESVAL(1,6)=100.,.015,20.,12*0.,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,1.,1.,6*0.,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,2.,1.,6*0.,
DESVAL(1,9)=7*0.,1.1,
DESVAL(1,10)=250.,.016,13*0.,
DESVAL(1,11)=1.,14*0.,
DESVAL(1,12)=50000.,.3,.85,12*0.,
DESVAL(1,13)=50000.,.3,13*0.,
&END

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*      *
*  FAN  2  *
*      *

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*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.524	570.	519.	1905.	1579.	6.9517	1.4005

U TIP	STRESS	DEN	W/AREA	TR	H/T
1258.9	15927.2	0.100	1.393	1.800	0.450

COMPRESSOR 2 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.874	3.00	39.98	1258.9	7216.9	7216.9

FRAME WT = 236.83

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 48. 35. 0. 0. 11. 3.1 0.100 0.168 3.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4789 16.7 0.524 6.952 8.99 19.99 59 1258.9 19272. 95. 519.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 38. 24. 0. 24. 9. 2.9 0.100 0.168 3.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4155 16.7 0.499 5.180 8.99 17.84 57 1123.7 14439. 95. 588.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 31. 18. 0. 24. 9. 2.9 0.100 0.168 2.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3671 16.7 0.475 4.017 8.99 16.28 52 1025.3 11248. 81. 658.

FRAME WT = 207.45

N STG WEIGHT LENGTH
 3 715.32 13.51

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 3.2206 1.3951

PR AD EF PD TO HP
 2.8600 0.8700 5447.2 726.9 16910.
 HI HO WI CWI
 123.95 174.07 238.50 265.00

***** TOTAL COMP WEIGHT IS 715.323

 * *
 * HPC 5 *
 * *
 *****2

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 1.8196 1.3951

U TIP STRESS DEN W/AREA TR H/T
 1413.6 28231.1 0.168 0.687 1.200 0.700

COMPRESSOR 5 MECHANICAL DESIGN

LOADING N STG DIAM U TIP C RPM C RPM
 0.538 10.00 25.58 1194.1 12667.1 10700.2

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 31. 14. 14. 36. 10. 4.5 0.168 0.168 2.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3603 17.8 0.450 1.820 8.95 12.79 50 1413.6 28231. 106. 727.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 32. 8. 8. 28. 8. 3.5 0.168 0.168 1.94
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3241 17.8 0.435 1.442 9.87 12.79 64 1413.6 22411. 85. 800.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 28. 6. 6. 23. 7. 2.9 0.168 0.168 1.89
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2948 17.8 0.420 1.171 10.48 12.79 78 1413.6 18215. 70. 873.

STAGE 4
 WD WB WS WN WC CL RHOB RHOD AR
 24. 4. 4. 19. 6. 2.4 0.168 0.168 1.83
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2704 17.8 0.405 0.970 10.91 12.79 94 1413.6 15103. 58. 946.

STAGE 5
 WD WB WS WN WC CL RHOB RHOD AR
 21. 3. 3. 17. 5. 2.1 0.168 0.168 1.78
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2499 17.8 0.390 0.818 11.23 12.79 109 1413.6 12743. 49. 1017.

STAGE 6
 WD WB WS WN WC CL RHOB RHOD AR
 18. 3. 3. 15. 4. 1.8 0.168 0.168 1.72
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2324 17.8 0.375 0.701 11.46 12.79 125 1413.6 10916. 42. 1089.

STAGE 7
 WD WB WS WN WC CL RHOB RHOD AR
 16. 2. 2. 13. 4. 1.6 0.168 0.168 1.67
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2173 17.8 0.360 0.608 11.65 12.79 140 1413.6 9476. 36. 1159.

STAGE 8
 WD WB WS WN WC CL RHOB RHOD AR
 28. 3. 3. 12. 3. 1.4 0.286 0.286 1.61
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.2042 17.8 0.345 0.534 11.79 12.79 155 1413.6 14176. 48. 1229.

STAGE 9
 WD WB WS WN WC CL RHOB RHOD AR
 25. 2. 2. 11. 3. 1.3 0.286 0.286 1.56
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.1926 17.8 0.330 0.475 11.91 12.79 170 1413.6 12596. 43. 1299.

STAGE 10
 WD WB WS WN WC CL RHOB RHOD AR
 23. 2. 2. 10. 3. 1.2 0.286 0.286 1.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.1824 17.8 0.315 0.426 12.00 12.79 183 1413.6 11308. 40. 1367.

N STG WEIGHT LENGTH
10 576.84 22.71

DUCT

M NO VEL T TOT P TOT P STAT AREA GAM
0.300 544. 1436. 51236. 48231. 0.3874 1.3539

PR AD EF PO TO HP
9.4060 0.8700 51235.9 1435.6 33965.
HI HO WI CWI
174.07 352.23 134.75 61.97

***** TOTAL COMP WEIGHT IS 576.837

* *
* PBUR 6 *
* *

*****2

BURNER NUMBER

6

RIN	ROUT	LENGTH	MACH	WSPEC		
18.842	21.094	18.000	0.055	4.596		
CAS WT	LIN WT	NOZ WT	INC WT	FRAME	WTOT	
64.7	74.5	17.8	57.8	0.0	214.9	

* *
* HPT 7 *
* *

*****2

DUCT

M NO VEL T TOT P TOT P STAT AREA GAM
0.500 1186. 2621. 46112. 39327. 0.3977 1.2968

U TIP STRESS DEN W/AREA TR H/T
1564.2 11881.4 0.286 0.189 1.000 0.953

TURBINE 7 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA			
0.953	1.000	0.280	0.398			
UT	RTIP	RHUB	DEL H	RPM	TORQ	
1564.2	14.2	13.5	174.5	12667.1	169012.	

STAGE 1

DISK BLADE VANE HWD CASE AR
18.3 1.7 6.4 29.4 3.9 1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
3.6978	174.5	0.500	0.398	13.49	14.15	303	1564.2	11881.	59.66	1.54

N STG LENGTH WEIGHT
1 1.54 59.66

DUCT

M NO VEL T TOT P TOT P STAT AREA GAM
0.550 1149. 2028. 12436. 10243. 1.2074 1.3127

PR	TR	AD EF	PO	TO	TO.1
3.7081	1.2928	0.8600	12435.6	2027.7	2027.7
H IN	H OUT	AREA	FLOW	HP	
699.28	524.74	5.17	137.56	33969.	

***** TOTAL TURB WEIGHT IS 59.662

* *

* LPT 8 *

* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1149.	2028.	12438.	10245.	1.2072	1.3127

U TIP	STRESS	DEN	W/AREA	TR	H/T
727.0	11708.5	0.286	0.777	1.000	0.765

TURBINE 8 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA
0.765	2.000	0.243	1.207

UT	RTIP	RHUB	DEL H	RPM	TORQ
727.0	11.5	8.8	86.9	7216.9	147693.

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR
5.0	22.4	66.0	38.9	9.9	2.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.4669	43.4	0.550	1.207	8.83	11.54	80	727.0	11709.	142.18	4.77

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR
5.6	29.3	86.6	31.1	9.4	3.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.5156	43.4	0.575	1.652	8.23	11.98	90	754.3	16019.	162.04	4.38

FRAME WT = 144.40

N STG	LENGTH	WEIGHT
2	13.73	448.62

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.600	1154.	1722.	5594.	4436.	2.3313	1.3249

PR	TR	AD EF	PO	TO	TO.1
2.2236	1.1779	0.8600	5593.7	1721.5	1721.5
H IN	H OUT	AREA	FLOW	HP	
524.77	437.87	16.80	137.56	16912.	

***** TOTAL TURB WEIGHT IS 448.624

* *

* FMIX 9 *

* *

*****2

LENGTH= 29.28 WEIGHT = 218.11

* *

* DBUR 10 *

* *

*****2

BURNER NUMBER 10

PIN	ROUT	LENGTH	MACH	WSPEC
0.0	24.120	48.000	0.143	11.899
CAS WT	LIN WT	NOZ WT	INC WT	WTOT
23.7	120.0	296.1	0.0	439.8

* *

* NOZ 11 *

* *

*****2

NOZZLE 11

WEIGHT= 206.89 LENGTH= 48.239 TR WT= 0.0

* *

* DUCT 4 *

* *

*****2

DUCT , 4

RH= 12.76 RT= 15.07 LENG= 55.98

APEA= 1.401 RHO=.168

CAS WT	INC WT	WTOT
10.1546	8.6000	18.7546

* *

* SHAF 12 *

* *

*****2

SHAFT 12

DO	DI	LENG	DN	WT
3.54	3.01	42.26	0.65	34.71

* *

* SHAF 13 *

* *

*****2

SHAFT 13

DO	DI	LENG	DN	WT
4.32	3.94	18.00	1.39	13.04

* *

* ACCS WT *

* *

*****2

ACCS WT= 273.972

WEIGHT INPUT DATA IN ENGL UNITS
 WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS		DOWNSTREAM RADIUS				NSTAGE		
				RI	RO	RI	RO	RI	RO			
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	715.	14.	14.	9.	20.	0.	0.	9.	15.	0.	0.	3
3	0.	0.	14.	0.	0.	0.	0.	9.	13.	13.	15.	0
4	19.	56.	69.	13.	15.	0.	0.	13.	15.	0.	0.	0
5	577.	23.	36.	9.	13.	0.	0.	12.	13.	0.	0.	10
6	215.	18.	54.	19.	21.	0.	0.	19.	21.	0.	0.	0
7	60.	2.	56.	13.	14.	0.	0.	12.	14.	0.	0.	1
8	449.	14.	69.	9.	12.	0.	0.	7.	13.	0.	0.	2
9	218.	29.	99.	0.	15.	15.	21.	0.	21.	0.	0.	0
10	440.	48.	147.	0.	24.	0.	0.	0.	24.	0.	0.	0
11	207.	48.	195.	0.	24.	0.	0.	0.	22.	0.	0.	0
12	35.	0.	0.	9.	20.	13.	14.	0.	0.	0.	0.	0
13	13.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 2947. ACCESSORIES= 273.97

ESTIMATED TOTAL LENGTH= 195. ESTIMATED MAXIMUM RADIUS= 24.

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.238500 03	0.146960 02	0.518670 03	0.0	0.238500 03	0.0	0.0	0.0
2	0.238500 03	0.132260 02	0.518670 03	0.0	0.264990 03	0.0	0.0	0.0
4	0.238500 03	0.378280 02	0.726870 03	0.0	0.109690 03	0.0	0.0	0.0
5	0.134750 03	0.378280 02	0.726870 03	0.0	0.619700 02	0.0	0.0	0.0
6	0.131240 03	0.355810 03	0.143560 04	0.0	0.901830 01	0.0	0.0	0.0
7	0.350340 01	0.355810 03	0.143560 04	0.0	0.0	0.0	0.0	0.0
8	0.134050 03	0.320220 03	0.265000 04	0.214250-01	0.139060 02	0.0	0.0	0.0
9	0.137560 03	0.863760 02	0.202780 04	0.208680-01	0.462760 02	0.0	0.0	0.0
10	0.137560 03	0.388490 02	0.172160 04	0.208680-01	0.948010 02	0.240000 00	0.374010 02	0.0
11	0.103750 03	0.378280 02	0.726870 03	0.0	0.477170 02	0.0	0.0	0.0
12	0.241310 03	0.374010 02	0.131570 04	0.117900-01	0.151010 03	0.0	0.0	0.0
13	0.241310 03	0.351570 02	0.131570 04	0.117900-01	0.160650 03	0.100000 01	0.187800 02	0.0
14	0.241310 03	0.351570 02	0.131570 04	0.117900-01	0.160650 03	0.117290 01	0.146960 02	0.0
15	0.103750 03	0.378280 02	0.726870 03	0.0	0.477170 02	0.127340 00	0.374010 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NC. TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	0.0	0.0	0.0	0.100000 01	0.100000 01	0.0	0.900000 00	0.100000 01	0.0
2 COMPRESR	-0.169120 05	0.400000 04	0.0	0.180000 01	0.400000 04	0.100000 01	0.265900 03	0.870000 00	0.286000 01
3 SPLITTER	0.770000 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESR	-0.339690 05	0.600000 04	0.0	0.130000 01	0.514550 04	0.985000 00	0.614180 02	0.870000 00	0.940600 01
6 DUCT B	0.0	0.100000 00	0.0	0.214250-01	0.0	0.101230 05	0.0	0.940000 00	0.265000 04
7 TURBINE	0.339690 05	0.600000 04	0.100000 01	0.400000 01	0.467330 00	0.568000 04	0.706450 00	0.860000 00	0.370730 01
8 TURBINE	0.169120 05	0.400000 04	0.100000 01	0.250000 01	0.385770 00	0.524400 04	0.726330 00	0.860000 00	0.222340 01
9 MIXER	0.707730 03	0.639250 03	0.103870 01	0.101140 01	0.472740 03	0.167730 03	0.0	0.949900-16	0.100000 01
10 DUCT B	0.0	0.600000-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 NOZZLE	0.137850 05	0.183790 04	0.239230 01	0.483930 03	0.472880 03	0.100000 01	0.980000 00	0.187210 01	0.239230 01
12 SHAFT	0.0	0.400000 04	0.400000 04	0.400000 04	0.0	0.0	0.0	0.0	0.0

13	SHAFT	0.0	0.600000 04	0.600000 04	0.600000 04	0.0	0.0	0.0	0.0	0.0
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MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL

&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

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&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

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THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL

CONFIGURATION DATA		15 STATIONS	21 COMPONENTS
COMPONENT NUMBER	NKIND COMPONENT TYPE	UPSTREAM STATIONS	DOWNSTREAM STATIONS

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14	VARY DATINP	1 OF COMPONENT	8 SO THAT STATP	8 OF FLOW STATION	13 EQUALS	0.0
15	VARY DATINP	1 OF COMPONENT	7 SO THAT STATP	8 OF FLOW STATION	9 EQUALS	0.0
16	VARY DATINP	1 OF COMPONENT	5 SO THAT STATP	8 OF FLOW STATION	8 EQUALS	0.0
17	VARY DATINP	1 OF COMPONENT	3 SO THAT DATOUT	8 OF COMPONENT	9 EQUALS	0.0
18	VARY DATINP	1 OF COMPONENT	2 SO THAT STATP	8 OF FLOW STATION	5 EQUALS	0.0
19	VARY DATINP	1 OF COMPONENT	1 SO THAT STATP	8 OF FLOW STATION	2 EQUALS	0.0
20	VARY DATINP	1 OF COMPONENT	12 SO THAT DATOUT	8 OF COMPONENT	12 EQUALS	0.0
21	VARY DATINP	1 OF COMPONENT	13 SO THAT DATOUT	8 OF COMPONENT	13 EQUALS	0.0

CASE IDENTIFICATION SIMPLE MODEL

COMPONENT		DATINP1		DATINP2		DATINP3		DATINP4		DATINP5		DATINP6		DATINP7		DATINP8		DATINP9	
NO.	TYPE																		
1	INLET	0.23850D	03	0.0		0.0		0.0		0.0		0.90000D	00	0.0		0.0		0.0	
2	COMPRESR	0.18000D	01	0.0		0.10000D	01	0.37610D	04	0.10000D	01	0.37620D	04	0.10000D	01	0.37630D	04	0.10000D	01
3	SPLITTER	0.77000D	00	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
4	DUCT B	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
5	COMPRESR	0.13000D	01	0.26000D	-01	0.10000D	01	0.37070D	04	0.10000D	01	0.37080D	04	0.10000D	01	0.37090D	04	0.10000D	01
6	DUCT B	0.10000D	00	0.0		0.0		0.26500D	04	0.94000D	00	0.18300D	05	0.0		0.0		0.0	
7	TURBINE	0.40000D	01	0.10000D	01	0.10000D	01	0.38010D	04	0.10000D	01	0.38020D	04	0.10000D	01	0.10000D	01	0.10000D	01
8	TURBINE	0.25000D	01	0.0		0.10000D	01	0.38030D	04	0.10000D	01	0.38040D	04	0.10000D	01	0.10000D	01	0.10000D	01
9	MIXER	0.0		0.0		0.24000D	00	0.0		0.0		0.0		0.0		0.0		0.0	
10	DUCT B	0.60000D	-01	0.0		0.0		0.0		0.90000D	00	0.18300D	05	0.0		0.0		0.0	
11	NOZZLE	0.0		0.10000D	01	0.0		0.0		0.98000D	00	0.10000D	01	0.0		0.0		0.10000D	01
12	SHAFT	0.40000D	04	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01
13	SHAFT	0.60000D	04	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01	0.10000D	01
14	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.80000D	01	0.0		0.0		0.10000D	01
15	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.80000D	01	0.0		0.0		0.10000D	01
16	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.80000D	01	0.0		0.0		0.10000D	01
17	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.0		0.80000D	01	0.0		0.10000D	01
18	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.80000D	01	0.0		0.0		0.10000D	01
19	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.80000D	01	0.0		0.0		0.10000D	01
20	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.0		0.80000D	01	0.0		0.10000D	01
21	CONTROL	0.0		0.0		0.0		0.10000D	01	0.0		0.0		0.80000D	01	0.0		0.10000D	01

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MODE      1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISID=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',0,5*0,
IWMEC(1,5)='LPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='DUCT',2,4*0,
IWMEC(1,11)='NOZ ',1,10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,
DESVAL(1,3)=15*0.,
DESVAL(1,4)=.45,2*0.,11.,11*0.,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,
DESVAL(1,6)=100.,.015,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,6*0.,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,6*0.,
DESVAL(1,9)=15*0.,
DESVAL(1,10)=.1,2.,
DESVAL(1,11)=1.,14*0.,
DESVAL(1,12)=50000.,.3,.85,12*0.,
DESVAL(1,13)=50000.,.3,13*0.,
&END

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*          *
*  FAN    2  *
*          *

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*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.524	570.	519.	1905.	1579.	6.9517	1.4005

U TIP	STRESS	DEN	W/AREA	TR	H/T
1258.9	26757.6	0.168	2.339	1.800	0.450

COMPRESSOR 2 MECHANICAL DESIGN

LOADING	N STG	DIAM	U TIP C	RPM	C RPM
0.874	3.00	39.98	1258.9	7216.9	7216.9

FRAME WT = 95.67

STAGE 1
 WD WB WS WN WC CL RHOB RHOD AR
 65. 59. 59. 0. 26. 7.4 0.168 0.168 3.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4789 16.7 0.524 6.952 8.99 19.99 59 1258.9 26758. 209. 519.

STAGE 2
 WD WB WS WN WC CL RHOB RHOD AR
 91. 34. 34. 51. 21. 6.2 0.168 0.168 3.00
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.4155 16.7 0.499 5.180 11.02 18.95 67 1193.2 20191. 231. 588.

STAGE 3
 WD WB WS WN WC CL RHOB RHOD AR
 97. 23. 23. 46. 19. 5.7 0.168 0.168 2.50
 PR DEL H MACH AREA R HUB R TIP NB U TIP STR WEIGHT TIN
 1.3671 16.7 0.475 4.017 12.17 18.23 70 1148.1 15768. 208. 658.

FRAME WT = 285.15

N STG WEIGHT LENGTH
 3 1028.68 28.80

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 3.2206 1.3951
 PR AD EF PO TO HP
 2.8600 0.8700 5447.2 726.9 16910.
 HI HO WI CWI
 123.95 174.07 238.50 265.00

***** TOTAL COMP WEIGHT IS 1028.680

 * *
 * LPC 5 *
 * *
 *****2

DUCT
 M NO VEL T TOT P TOT P STAT AREA GAM
 0.450 582. 727. 5447. 4743. 1.8196 1.3951

U TIP STRESS DEN W/AREA TR H/T
 1285.1 23331.5 0.168 0.687 1.200 0.700

COMPRESSOR 5 MECHANICAL DESIGN

LOADING N STG DIAM U TIP C RPM C RPM
 0.651 10.00 25.58 1085.6 11515.5 9727.5

FRAME WT = 118.22

STAGE 1														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
24.	14.	14.	36.	10.	4.5	0.168	0.168	2.00						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.3603	17.8	0.450	1.820	8.95	12.79	50	1285.1	23331.	99.	727.				

STAGE 2														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
20.	9.	9.	29.	8.	3.6	0.168	0.168	1.94						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.3241	17.8	0.435	1.442	9.42	12.45	60	1250.7	18516.	75.	800.				

STAGE 3														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
16.	6.	6.	25.	7.	3.0	0.168	0.168	1.89						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2948	17.8	0.420	1.171	9.75	12.19	70	1225.3	15048.	59.	873.				

STAGE 4														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
13.	4.	4.	21.	6.	2.6	0.168	0.168	1.83						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2704	17.8	0.405	0.970	9.98	12.00	81	1206.2	12477.	49.	946.				

STAGE 5														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
11.	3.	3.	18.	5.	2.2	0.168	0.168	1.78						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2499	17.8	0.390	0.818	10.15	11.86	93	1191.5	10527.	41.	1017.				

STAGE 6														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
10.	3.	3.	16.	4.	2.0	0.168	0.168	1.72						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2324	17.8	0.375	0.701	10.28	11.74	104	1180.1	9018.	36.	1089.				

STAGE 7														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
9.	2.	2.	14.	4.	1.8	0.168	0.168	1.67						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2173	17.8	0.360	0.608	10.39	11.65	115	1171.0	7829.	32.	1159.				

STAGE 8														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
16.	3.	3.	13.	3.	1.6	0.286	0.286	1.61						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.2042	17.8	0.345	0.534	10.47	11.58	126	1163.6	11712.	39.	1229.				

STAGE 9														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
15.	3.	3.	12.	3.	1.5	0.286	0.286	1.56						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.1926	17.8	0.330	0.475	10.53	11.52	136	1157.7	10407.	36.	1299.				

STAGE 10														
WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR						
15.	2.	2.	11.	3.	1.4	0.286	0.286	1.50						
PR	DEL	H	MACH	AREA	R	HUB	R	TIP	NB	U	TIP	STR	WEIGHT	TIN
1.1824	17.8	0.315	0.426	10.59	11.47	146	1152.8	9343.	33.	1367.				

N STG WEIGHT LENGTH
10 616.48 25.43

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.300	544.	1436.	51236.	48231.	0.3874	1.3539

PR	AD EF	PO	TO	HP
9.4060	0.8700	51235.9	1435.6	33965.
HI	HO	WI	CWI	
174.07	352.23	134.75	61.97	

***** TOTAL COMP WEIGHT IS 616.477

* *
* PBUR 6 *
* *

*****2

BURNER NUMBER		6				
RIN	ROUT	LENGTH	MACH	WSPEC		
8.758	12.909	18.000	0.055	4.596		
CAS WT	LIN WT	NOZ WT	INC WT	FRAME	WTOT	
24.2	40.4	17.8	16.4	151.3	250.2	

* *
* HPT 7 *
* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.500	1186.	2621.	46112.	39327.	0.3977	1.2968

U TIP	STRESS	DEN	W/AREA	TR	H/T
1106.0	9819.5	0.286	0.246	1.000	0.922

TURBINE 7 MECHANICAL DESIGN					
H/T	N STG	LOADING	AREA		
0.922	2.000	0.280	0.398		
UT	RTIP	RHUB	DEL H	RPM	TORQ
1106.0	11.0	10.1	174.5	11515.5	185913.

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR						
6.4	2.3	8.4	21.7	4.0	1.50						
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
1.8453	87.3	0.500	0.398	10.14	11.01	180	1106.0	9820.	42.84	2.02	

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR						
10.8	6.4	23.7	35.5	6.8	1.50						
PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH	
2.0063	87.3	0.525	0.666	10.14	11.55	116	1160.9	16456.	83.19	3.29	

N STG	LENGTH	WEIGHT
2	5.31	126.03

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1149.	2028.	12436.	10243.	1.2074	1.3127

PR	TR	AD EF	PO	TO	TO.1
3.7081	1.2928	0.8600	12435.6	2027.7	2027.7
H IN	H OUT	AREA	FLOW	HP	
699.28	524.74	5.17	137.56	33969.	

***** TOTAL TURB WEIGHT IS 126.028

* *
* LPT 8 *
* *

*****2

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.550	1149.	2028.	12438.	10245.	1.2072	1.3127

U TIP	STRESS	DEN	W/AREA	TR	H/T
727.0	11708.5	0.286	0.777	1.000	0.765

TURBINE 8 MECHANICAL DESIGN

H/T	N STG	LOADING	AREA
0.765	2.000	0.243	1.207

UT	RTIP	RHUB	DEL H	RPM	TORQ
727.0	11.5	8.8	86.9	7216.9	147693.

STAGE 1

DISK	BLADE	VANE	HWD	CASE	AR
5.0	22.4	66.0	38.9	9.9	2.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.4669	43.4	0.550	1.207	8.83	11.54	80	727.0	11709.	142.18	4.77

STAGE 2

DISK	BLADE	VANE	HWD	CASE	AR
6.9	27.6	81.4	34.0	9.3	3.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB	U TIP	STR	WEIGHT	LENGTH
1.5156	43.4	0.575	1.652	8.83	12.39	98	780.6	16019.	159.21	4.17

FRAME WT = 167.79

N STG	LENGTH	WEIGHT
2	13.41	469.18

DUCT

M NO	VEL	T TOT	P TOT	P STAT	AREA	GAM
0.600	1154.	1722.	5594.	4436.	2.3313	1.3249

PR	TR	AD EF	PO	TO	TO.1
2.2236	1.1779	0.8600	5593.7	1721.5	1721.5
H IN	H OUT	AREA	FLOW	HP	
524.77	437.87	16.80	137.56	16912.	

***** TOTAL TURB WEIGHT IS 469.184

* *

* DUCT 10 *

* *

*****2

DUCT , 10

RH= 0.0 RT= 28.80 LENG= 57.60

AREA= 18.098 RHO=.286

CAS WT	INC WT	WTOT
45.8800	0.0	45.8800

* *

* NOZ 11 *

* *

*****2

NOZZLE 11

WEIGHT= 295.02 LENGTH= 57.604 TR WT= 0.0

* *

* DUCT 4 *

* *

*****2

DUCT , 4

RH= 15.78 RT= 17.69 LENG= 62.16

AREA= 1.401 RHO=.168

CAS WT	INC WT	WTOT
15.5408	13.8556	29.3964

* *

* SHAF 12 *

* *

*****2

SHAFT 12

DO	DI	LENG	DN	WT
3.54	3.01	48.74	0.65	40.03

* *

* SHAF 13 *

* *

*****2

SHAFT 13

DO	DI	LENG	DN	WT
4.35	3.94	18.00	1.27	14.33

* *

* ACCS WT *

* *

*****2

ACCS WT= 262.021

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS		RADIUS		DOWNSTREAM RADIUS				NSTAGE
				RI	RO	RI	RO	RI	RO	RI	RO	
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	1029.	29.	29.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	29.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	29.	62.	91.	16.	18.	0.	0.	16.	18.	0.	0.	0
5	616.	25.	54.	9.	13.	0.	0.	11.	11.	0.	0.	10
6	250.	18.	72.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	126.	5.	78.	10.	11.	0.	0.	10.	13.	0.	0.	2
8	469.	13.	91.	9.	12.	0.	0.	9.	14.	0.	0.	2
9	0.	0.	91.	4.	16.	16.	21.	4.	21.	0.	0.	0
10	46.	58.	149.	0.	29.	0.	0.	0.	29.	0.	0.	0
11	295.	58.	206.	0.	29.	0.	0.	0.	27.	0.	0.	0
12	40.	0.	0.	9.	20.	10.	11.	0.	0.	0.	0.	0
13	14.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 2915. ACCESSORIES= 262.02

ESTIMATED TOTAL LENGTH= 206. ESTIMATED MAXIMUM RADIUS= 29.

[illegible]

A-60

[illegible]

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.238500 03	0.146960 02	0.518670 03	0.0	0.238500 03	0.0	0.0	0.0
2	0.238500 03	0.132260 02	0.518670 03	0.0	0.264990 03	0.0	0.0	0.0
4	0.238500 03	0.378280 02	0.726870 03	0.0	0.109690 03	0.0	0.0	0.0
5	0.134750 03	0.378280 02	0.726870 03	0.0	0.619700 02	0.0	0.0	0.0
6	0.131240 03	0.355810 03	0.143560 04	0.0	0.901830 01	0.0	0.0	0.0
7	0.350340 01	0.355810 03	0.143560 04	0.0	0.0	0.0	0.0	0.0
8	0.134050 03	0.320220 03	0.265000 04	0.214250-01	0.139060 02	0.0	0.0	0.0
9	0.137560 03	0.863760 02	0.202780 04	0.208680-01	0.462760 02	0.0	0.0	0.0
10	0.137560 03	0.388490 02	0.172160 04	0.208680-01	0.948010 02	0.240000 00	0.374010 02	0.0
11	0.103750 03	0.378280 02	0.726870 03	0.0	0.477170 02	0.0	0.0	0.0
12	0.241310 03	0.374010 02	0.131570 04	0.117900-01	0.151010 03	0.0	0.0	0.0
13	0.241310 03	0.351570 02	0.131570 04	0.117500-01	0.160650 03	0.100000 01	0.187800 02	0.0
14	0.241310 03	0.351570 02	0.131570 04	0.117900-01	0.160650 03	0.117290 01	0.146960 02	0.0
15	0.103750 03	0.378280 02	0.726870 03	0.0	0.477170 02	0.127340 00	0.374010 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO. TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	0.0	0.0	0.0	0.100000 01	0.100000 01	0.0	0.900000 00	0.100000 01	0.0
2 COMPRESSR	-0.169120 05	0.400000 04	0.0	0.180000 01	0.400000 04	0.100000 01	0.265900 03	0.870000 00	0.286000 01
3 SPLITTER	0.770000 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 COMPRESSR	-0.339690 05	0.600000 04	0.0	0.130000 01	0.514550 04	0.985000 00	0.614180 02	0.870000 00	0.940600 01
6 DUCT B	0.0	0.100000 00	0.0	0.214250-01	0.0	0.101230 05	0.0	0.940000 00	0.265000 04
7 TURBINE	0.339690 05	0.600000 04	0.100000 01	0.400000 01	0.467330 00	0.568000 04	0.706450 00	0.860000 00	0.370730 01
8 TURBINE	0.169120 05	0.400000 04	0.100000 01	0.250000 01	0.385770 00	0.524400 04	0.726330 00	0.860000 00	0.222340 01
9 MIXER	0.707730 03	0.639250 03	0.103870 01	0.101140 01	0.472740 03	0.167730 03	0.0	0.949900-16	0.100000 01
10 DUCT B	0.0	0.600000-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 NOZZLE	0.137850 05	0.183790 04	0.239230 01	0.483930 03	0.472880 03	0.100000 01	0.980000 00	0.187210 01	0.239230 01
12 SHAFT	0.0	0.400000 04	0.400000 04	0.400000 04	0.0	0.0	0.0	0.0	0.0

13	SHAFT	0.0	0.600000 04	0.600000 04	0.600000 04	0.0	0.0	0.0	0.0
----	-------	-----	-------------	-------------	-------------	-----	-----	-----	-----

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 Q ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

APPENDIX B – Source Listing

By programming standards each routine starts with an extensive set of COMMENT cards which describe the subroutine purpose, use, required subroutines, history, and glossary of variable names and descriptions. The listing of NNEP has been skipped to save space. The changes to NNEP necessary to append the weight estimating routines are.

1. Add calls to WTEST in MAIN and NEPCAL
2. Incorporate common WMECH in routine INPUT
3. Incorporate variables IWT and IPLT in namelist statement D in routine INPUT

SUBROUTINE	Page
COMP – Initialize Compressor Conditions	B-2
CMECH – Compressor Mechanical Design	B-12
CWT – Compressor Weight Calculations	B-21
COMBWT – Combustor Weight Calculations	B-24
DUCTWT – Duct Weight Calculations	B-29
DUCT – Inlet Area Calculation	B-33
DUCT1 – Stage Mach Number of Area Calculation	B-36
EFFD – Component Polytropic Calculation	B-38
FRAME – Frame Weight Calculations	B-40
STESSS – Blade Pull Stress Calculations	B-42
SHAFT – Shaft Weight Calculations	B-44
TURB – Initialize Turbine Conditions	B-48
TMECH – Turbine Mechanical Design	B-54
TURWT – Turbine Weight Calculations	B-62
WMIXR – Mixer Weight Calculation	B-65
WSPLT – Splitter Radu Calculation	B-68
WTNOZ – Nozzle Weight Calculation	B-70
STHERM – Thermodynamic Tables	B-74
WTEST – Main Driver Routine	B-75
NPPNT – Plotter Routine	B-82
DTRAP – Trapezoid Plotting Routine	B-84
ENGPLT – Engine Plotting Routine	B-86
DUMMY – Dimension Transfer Routine	B-90
HMEC – Heat Exchanger Weight Calculation	B-92
VALVWT – Air Inverter Valve Weight Calculation	B-97

```

C*****
C
C SUBROUTINE (COMP)
C -----
C
C PURPOSE
C -----
C   THIS ROUTINE INITIALIZES THE INLET AND EXIT
C   CONDITIONS FOR ALL TYPES OF COMPRESSORS AND
C   CALLS THE MECHANICAL DESIGN ROUTINE.
C
C CALLING ROUTINES
C -----
C
C
C REQUIRED SUBROUTINES
C -----
C   CMECH      DOES THE MECHANICAL DESIGN
C   DUCT       CALCULATES AREA BASED ON MACH
C   DUCT1      CALCULATES AREA BASED ON MACH OR
C               MACH BASED ON AREA
C   EFFD       CALCULATES POLYTROPIC EFFICIENCY FROM
C               ADIABATIC EFFICIENCY
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C AUTHOR /LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C   ICOMP      ARG          L          COMPONENT NUMBER
C   IP          O           O          PRINT INDICATOR
C   NCC          O           O          COMPONENT NUMBER
C   NC          O           O          COMPONENT TYPE
C                                   1= FAN
C                                   3= COMPRESSOR
C   NCDEI      O           O          INLET NODE
C   NCDEC      O           O          OUTLET NODE
C   WI          O           O          AIRFLOW IN
C   PI          O           O          PRESSURE IN
C   TI          O           O          TEMPERATURE IN
C   PR          O           O          PRESSURE RATIO
C   EF          O           O          ADIABATIC EFFICIENCY
C   PEF        O           O          POLYTROPIC EFFICIENCY

```

C	IDES	INPUT INDICATOR
C		1=DATA FROM DESVAL
C		2=DATA FROM DEFAULT
C	AI	MACH IN
C	ITYPE	LOCATION INDICATOR FOR DEFAULT
C		1 THRU 5 =FAN
C		6 = LPC
C		7 = HPC
C	CW	CORRECTED AIRFLOW
C	PRC	PRESSURE RATIC
C	TID	DESIGN TEMPERATURE
C	H1	ENTHALPY IN
C	RP1	REL PRESSURE IN
C	RP3	REL PRESSURE OUT
C	T3	IDEAL TEMPERATURE OUT
C	H3	IDEAL ENTHALPY OUT
C	DHI	IDEAL DELTA ENTHALPY
C	DHA	DELTA ENTHALPY
C	H2	ENTHALPY OUT
C	TC	TEMPERATURE OUT
C	PO1	PRESSURE OUT
C	XM	MACH IN
C	AO	AREA GUT
C		
C	FCR NON-ROTATING SPLITTERS	
C	IFAN	INDICATES FAN INNER
C		OR FAN OUTER
C	NFAN	INDICATES FAN OUTER
C		OR FAN INNER
C	NCDEIC	NODE IN ON OUTER
C	NODEII	NODE IN ON INNER
C	WAI	AIRFLOW IN ON INNER
C	WAO	AIRFLOW IN ON OUTER
C	PRC	PRESSURE RATIO OF OUTER
C	EFO	EFFICIENCY OF OUTER
C	PPI	PRESSURE RATIO OF INNER
C	EFI	EFFICIENCY OF INNER
C	NCDEOC	NODE OUT ON OUTER
C	NODEOI	NODE OUT ON INNER
C	TCC	TEMPERATURE OUT ON OUTER
C	TCI	TEMPERATURE OUT ON INNER
C	WCC	AIRFLOW OUT ON OUTER
C	WOI	AIRFLOW OUT ON INNER
C	RPMT	RPM OF COMPONENT
C		
C	FCR RCTATING SPLITTERS	
C		
C	NFANI	INNER COMPONENT NUMBER
C	NFANO	OUTER COMPONENT NUMBER
C	PII	PRESSURE IN ON INNER
C	TII	TEMPERATURE IN ON INNER
C	WII	AIRFLOW IN ON INNER
C	PIO	PRESSURE IN ON OUTER
C	TIO	TEMPERATURE IN ON OUTER
C	WIO	AIRFLOW IN ON OUTER
C	FAI	F/A RATIO OF INNER

```

C  FAO          F/A RATIO OF OUTER
C  XMII         MACH IN ON INNER
C  XMIO         MACH IN ON OUTER
C  GAI          GAMMA INNER
C  GAO          GAMMA OUTER
C  ATI          TOTAL INLET AREA
C  ARI          AREA RATIO IN - A OUTER/A TOTAL
C  PCI          PRESSURE OUT ON INNER
C  TOI          TEMPERATURE OUT ON INNER
C  WOI          AIRFLOW OUT ON INNER
C  FOI          F/A RATIO OUT ON INNER
C  POC          PRESSURE OUT ON OUTER
C  TOO          TEMPERATURE OUT ON OUTER
C  WOC          AIRFLOW OUT ON OUTER
C  FOO          F/A RATIO OUT ON OUTER
C  XMOI         MACH OUT ON INNER
C  XMOO         MACH OUT ON OUTER
C  GOI          GAMMA OUT ON INNER
C  GCO          GAMMA OUT ON OUTER
C  ATO          TOTAL AREA OUT
C  ARO          AREA RATIO OUT -A OUTER/A TOTAL
C  NFO          OUTER FAN NUMBER
C
C
C *****
C
C
C  SUBROUTINE COMP (ICOMP)
C    REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C    1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C          *****
C          * COMMON BLOCKS *
C          *****
C
C    COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C    140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
C    2T,DEPV(20),DTOL(20),PERPF(20)
C    COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LCCTBL(9,60),JCOMP(70),IWAY,NIT,
C    1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C    2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C    3JCVIND(20),JCVDEP(20),KDTP(20),IDONE(60)
C    COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C    10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
C    2UTCD,NSTAG(60)
C    COMMON /CONVER/ CONVER(15)
C    COMMON /DEFAULT/ DEFAULT(15,20)
C    LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C          *****
C          * DATA STATEMENTS *
C          *****
C
C    DATA TSTD,PSTD,FA/518.67,2116.22,0./
C    DATA LLPC,LHPC,LFAN,LFO,LFI,LRSFO,LRSFI/4HLPC ,4HHPC ,4HFAN ,4HFO
C    1 ,4HFI ,4HRSFO,4HRSFI/

```

```

IF (IOUTCD.GT.1) WRITE (10,330) IWMEC(1,ICOMP),ICOMP,IOUTCD
IP=IOUTCD
ISP=0
NCC=ICOMP
ITYPE=1
NC=3
IF (IWMEC(1,NCC).EQ.LFAN) NC=1
IF (IWMEC(1,NCC).EQ.LFO) NC=1
IF (IWMEC(1,NCC).EQ.LFI) NC=1
IF (IWMEC(1,NCC).EQ.LRSFO) NC=4
IF (IWMEC(1,NCC).EQ.LRSFI) NC=4
IF (IWMEC(5,NCC).LE.-1) RETURN
IF (NC.EQ.4) GO TO 170
IF (NC.EQ.1.AND.IWMEC(5,NCC).NE.0) GO TO 40
NODEI=JCONF(NCC,1)
NODEO=JCONF(NCC,3)
WI=WTF(NODEI)
PII=TOPRES(NODEI)
PI=PII*144.
TI=TOTEMP(NODEI)
PR=DATOUT(9,NCC)
EF=DATOUT(8,NCC)
IDES=1
IF (DESVAL(1,NCC).EQ.0.) IDES=2
GO TO (10,20),IDES
10 AI=DESVAL(1,NCC)
GO TO 30
20 ITYPE=1
IF (IWMEC(1,NCC).EQ.LLPC) ITYPE=6
IF (IWMEC(1,NCC).EQ.LHPC) ITYPE=7
AI=DEFAULT(1,ITYPE)

C
C CALCULATE CORRECTED COMPONENT INLET FLOW (CW)
C
30 CW=WI*SQRT(TI/TSTD)/PI*PSTD
C
C CHECK FOR BAD INLET TOTAL TEMPERATURE (TI)
C
IF (TI.LT.200.) TI=200.
IF (TI.GT.6000.) TI=6000.

C
C INITIALIZE DESIGN CASE VALUES
C
PRD=PR
TID=TI
PEF=EF

C
C CALCULATE ADIABATIC (EF) OR POLYTROPIC (PEF) COMPONENT DESIGN
C EFFICIENCY
C
CALL EFFD (TID,PRD,PEF,EF,FA)

C
C CALCULATE INLET ENTHALPY (H1), IDEAL EXIT ENTHALPY (H3), IDEAL DELTA
C ENTHALPY (DHI), ACTUAL DELTA ENTHALPY (DHA), ACTUAL EXIT ENTHALPY
C (H2) AND EXIT TOTAL TEMPERATURE (TO)
C

```



```

      H1=STHERM(4,TI,FA)
      RP1=STHERM(2,TI,FA)
      RP3=RP1*PR
      T3=STHERM(3,RP3,FA)
      H3=STHERM(4,T3,FA)
      DHI=H3-H1
      DHA=DHI/EF
      H2=DHA+H1
      TO=STHERM(1,H2,FA)
C
C CALCULATE INLET DUCT AREA (AI)
C
      CALL DUCT (TI,PI,WI,AI,FA,XM,PS,Q,ISIO,IP)
C
C CALCULATE DUCT EXIT TOTAL PRESSURE (PO1), COMPONENT EXIT FLOW
C (WO) AND COMPONENT WORK (WHP)
C
      PO1=PI*PR
      WO=WTF(NCDEO)
      WHP=DHA*WI/.7068
C
C CALCULATE COMPONENT MECHANICAL DESIGN AND DIMENSIONS
C
      PO=PO1
      XMS=XM
      PEFS=PEF
      CALL CMECH (IP,IDES,NCC,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,0.,0.
      1,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEI,NODEO)
C
C CALCULATE COMPONENT EXIT AREA (AO)
C
      AO=XME
      WT1=WATE(NCC)
      CALL DUCT (TO,PO1,WI,AO,FA,XME,PS1,QFEX,ISIO,IP)
C
C WRITE COMPONENT DATA
C
      IF (IP.NE.2) RETURN
      GO TO 270
C
C CALCULATION FOR NON-ROTATING SPLITTER
C
C INITIALIZE DESIGN VALUES
40  IFAN=1
      ITYPE=2
      IF (IWMEC(1,NCC).EQ.LFI) IFAN=2
      NFAN=IWMEC(5,NCC)
      IWMEC(5,NFAN)=-NCC
      IF (IFAN.EQ.1) NODEIO=JCONF(NCC,1)
      IF (IFAN.EQ.1) NODEII=JCONF(NFAN,1)
      IF (IFAN.EQ.2) NODEIO=JCONF(NFAN,1)
      IF (IFAN.EQ.2) NODEII=JCONF(NCC,1)
      PII=TOPRES(NODEIO)
      PI=PII*144.
      TI=TOTEMP(NCDEIO)
      WAI=WTF(NODEII)

```

```

      WAO=WTF(NODEIO)
      WI=WAI+WAO
C
C   CALCULATE MASS WEIGHTED PR AND EF FOR STAGE CALC
C
      GO TO (50,60),IFAN
50    PRO=DATOUT(9,NCC)
      EFO=DATOUT(8,NCC)
      PRI=DATOUT(9,NFAN)
      EFI=DATOUT(8,NFAN)
      GO TO 70
60    PRO=DATOUT(9,NFAN)
      EFO=DATOUT(8,NFAN)
      PRI=DATOUT(9,NCC)
      EFI=DATOUT(8,NCC)
70    PR=(PRI*WAI+PRO*WAO)/WI
      EF=(EFI*WAI+EFO*WAO)/WI
      TID=TI
      PRD=PI
      PEF=EF
      CALL EFFD (TID,PRD,PEF,EF,FA)
      GO TO (80,90),IFAN
80    NODEOO=JCONF(NCC,3)
      NODEOI=JCONF(NFAN,3)
      GO TO 100
90    NODEOO=JCONF(NFAN,3)
      NODEOI=JCONF(NCC,3)
100   TOO=TOTEMP(NODEOO)
      TOI=TOTEMP(NODEOI)
      TO=(TOO*WAO+TOI*WAI)/WI
      WOC=WTF(NODEOO)
      WOI=WTF(NODEOI)
      WO=WGO+WOI
      IDES=1
      IF (DESVAL(1,NCC).EQ.0.) IDES=2
      GO TO (110,120),IDES
110   AI=DESVAL(1,NCC)
      GO TO 130
120   AI=DEFAULT(1,2)
C
C   CALCULATE INLET DUCT AREA (AI)
C
130   CALL DUCT (TI,PI,WI,AI,FA,XM,PS,Q,ISIO,IP)
C
C   CALCULATE INLET ENTHALPY AND WORK
C
      H1=STHERM(4,TI,FA)
      RP1=STHERM(2,TI,FA)
      RP3=RP1*PR
      T3=STHERM(3,RP3,FA)
      H3=STHERM(4,T3,FA)
      DHI=H3-H1
      DHA=DHI/EF
      H2=H1+DHA
      PO1=PI*PR

```

```

C   CALCULATE COMPRESSOR MECHANICAL DESIGN
C
    XMS=XM
    PEFS=PEF
    CALL CMECH (IP,IDES,NCC,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,0.,0.
1,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEIO,NODEOO)
    AO=XME
C
C   CALCULATE EXIT DUCT AREA (AO)
C
    CALL DUCT (TO,PO1,WO,AO,FA,XME,PSI,QFEX,ISIO,IP)
C
C   STORE WEIGHT AND DIMENSIONS FOR FAN
C
    RPMT(NFAN)=RPMT(NCC)
    GO TO (140,150),IFAN
140  WATE(NFAN)=WATE(NCC)*WAI/WI
    WATE(NCC)=WATE(NCC)-WATE(NFAN)
    ALENG(NFAN)=ALENG(NCC)
    RI(1,NODEII)=RI(1,NODEIO)
    RI(2,NODEOI)=RI(2,NODEOO)
    GO TO 160
150  WATE(NFAN)=WATE(NCC)*WAO/WI
    WT1=WATE(NCC)
    WATE(NCC)=WATE(NCC)-WATE(NFAN)
    ALENG(NFAN)=ALENG(NCC)
    RO(1,NODEIO)=RO(1,NODEII)
    RO(2,NODEOC)=RO(2,NODEOI)
160  RM=SQRT((RO(2,NODEIO)**2+RI(1,NODEII)**2*WAO/WAI)/(1.+WAO/WAI))
    RI(1,NODEIO)=RM
    RO(1,NODEII)=RM
    RM=SQRT((RO(2,NODEOO)**2+RI(2,NODEOI)**2*WAO/WAI)/(1.+WAO/WAI))
    RO(2,NODEOI)=RM
    RI(2,NODEOO)=RM
    IF (IP.NE.2) RETURN
    CW=CORFLO(NODEII)+CORFLO(NODEIO)
    CW=CW/1.54972555
    WHP=DHA*WI/.7068
    PO=PO1
    GO TO 270
C
C   CALCULATION FOR ROTATING SPLITTER
C   INITIALIZE DESIGN VALUES AND DETERMINE INNER AND OUTER FANS
C
170  ITYPE=4
    IFAN=2
    IF (IWMEC(1,NCC).EQ.LRSFO) IFAN=1
    GO TO (180,190),IFAN
180  NODEIO=JCONF(NCC,1)
    NODEOO=JCONF(NCC,3)
    NFANI=IWMEC(5,NCC)
    NFANO=NCC
    NODEII=JCONF(NFANI,1)
    NODEOI=JCONF(NFANI,3)
    IWMEC(5,NFANI)=-NCC
    GO TO 200

```

```

190  NODEII=JCONF(NCC,1)
      NODEOI=JCONF(NCC,3)
      NFANO=IWMEC(5,NCC)
      NFANI=NCC
      NODEIC=JCONF(NFANO,1)
      NODEOO=JCONF(NFANO,3)
      IWMEC(5,NFANO)=-NCC
200  PII=TOPRES(NODEII)*144.
      TII=TOTEMP(NODEII)
      WII=WTF(NODEII)
      PIO=TOPRES(NODEIO)*144.
      TIC=TOTEMP(NODEIO)
      WIO=WTF(NODEIO)
      FII=FAR(NODEII)
      FIC=FAR(NODEIO)
      IDES=1
      IF (DESVAL(1,NCC).EQ.0.) IDES=2
C
C  CALCULATE MACH IN AND MACH OUT FOR MECHANICAL DESIGN
C  AND CALCULATE OUTER TC TOTAL AREA RATIO FOR SPLITTER LOCATION
C
      GO TO (210,220), IDES
210  XMII=DESVAL(1,NFANI)
      XMIO=DESVAL(1,NFANO)
      GO TO 230
220  XMII=DEFAULT(1,5)
      XMIO=DEFAULT(1,4)
230  GII=STHERM(5,TII,FII)
      GIO=STHERM(5,TIO,FIO)
      AII=0.
      AIO=0.
      CALL DUCT1 (TII,PII,WII,GII,XMII,AII)
      CALL DUCT1 (TIO,PIO,WIO,GIO,XMIO,AIO)
      WI=WII+WIO
      ATI=AIO+AII
      TAT=-ATI
      CALL DUCT1 (TIO,PIO,WI,GIO,XMI,TAT)
      ARI=AIO/ATI
      POI=TOPRES(NODEOI)*144.
      TOI=TCTEMP(NODEOI)
      WOI=WTF(NODEOI)
      FOI=FAR(NODEOI)
      POC=TOPRES(NODEOO)*144.
      TOO=TOTEMP(NODEOO)
      WOO=WTF(NODEOO)
      FOO=FAR(NODEOO)
      GO TO (240,250), IDES
240  XMCI=DESVAL(7,NFANI)
      XMCO=DESVAL(7,NFANO)
      GO TO 260
250  XMOI=DEFAULT(7,5)
      XMCO=DEFAULT(7,4)
260  GOI=STHERM(5,TOI,FOI)
      GOO=STHERM(5,TOO,FOO)
      AOI=0.
      AOO=0.

```

```

CALL DUCT1 (TOI,POI,WOI,GOI,XMOI,AOI)
CALL DUCT1 (TOO,POO,WOO,GOO,XMOO,AOO)
ATC=ACI+AOO
TAO=-ATO
WO=WOO+WOI
CALL DUCT1 (TOO,POO,WC,GOC,XMO,TAO)
ARC=AOO/ATO
EF=DATOUT(8,NFANO)
PR=DATOUT(9,NFANO)
AI=ATI
AO=ATO
PRD=PR
TID=TIO
PEF=EF
CALL EFFD (TID,PRD,PEF,EF,FIO)
H1=STHERM(4,TIO,FIO)
RP1=STHERM(2,TIC,FIC)
RP3=RP1*PR
T3=STHERM(3,RP3,FIO)
H3=STHERM(4,T3,FIO)
DHI=H3-H1
DHA=DHI/EF
WHP=DHA*WI/.7068
H2=H1+DHA
TO=STHERM(1,H2,FIO)
TR=TO/TIO
W1=WI
PO1=PIO*PR

```

C
C
C CALCULATE COMPRESSOR MECHANICAL DESIGN

```

XMS=XMI
TI=TIO
PI=PIO
PEFS=PEF
NFO=NFANO
CALL CMECH (IP,IDES,NFO,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,ARO,A
1RI,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEIO,NODEOO)

```

C
C
C STORE FAN DIMENSIONS AND WEIGHT

```

WT1=WATE(NFANO)
RPMT(NFANI)=RPMT(NFANO)
WATE(NFANI)=WATE(NFANO)*WII/WI
WATE(NFANO)=WATE(NFANO)-WATE(NFANI)
ALENG(NFANI)=ALENG(NFANO)
RI(1,NODEII)=RI(1,NODEIO)
RI(2,NODEOI)=RI(2,NODEOO)
RM=SQRT(RO(1,NODEIO)**2-ARI*(RO(2,NODEIO)**2-RI(1,NODEII)**2))
RI(1,NODEIO)=RM
RO(1,NODEII)=RM
RM=SQRT(RO(2,NODEOO)**2-ARO*(RO(2,NODEOO)**2-RI(2,NODEOI)**2))
RI(2,NODEOO)=RM
RO(2,NODEOI)=RM
PO=PO1
CW=0.

```

```

270  IF (IP.NE.2) GO TO 290
      WRITE (10,340)
      IF (ISIO) GO TO 280
      WRITE (10,350) PR,EF,PO,TO,WHP
      WRITE (10,360)
      WRITE (10,370) H1,H2,WI,CW
      GO TO 290
280  SPO=PO*CONVER(11)
      STC=TO*CCNVER(8)
      SWHP=WHP*CCNVER(10)
      SH1=H1*CONVER(9)
      SH2=H2*CCNVER(9)
      SWI=WI*CONVER(3)
      SCW=CW*CCNVER(3)
      WRITE (10,350) PR,EF,SPO,STO,SWHP
      WRITE (10,360)
      WRITE (10,370) SH1,SH2,SWI,SCW
290  IF (IWMEC(6,NCC).EQ.0) GO TO 320
      IGR=IWMEC(6,NCC)
      DO 300 I=1,4
        ILOC=I
        IF (NCC.EQ.JCONF(IGR,I)) GO TO 310
300  CONTINUE
310  ILCC=ILCC+1
      GR=DATINP(ILOC,IGR)
      RPM=RPMT(NCC)
      GBWT=WHP/RPM*(1.+GR)**3/GR*9.43
      RPMT(NCC)=RPM/GR
      IF (NC.EQ.1) RPMT(NFAN)=RPMT(NCC)
      IF (NC.EQ.4) RPMT(NFANI)=RPMT(NCC)
      IF (NC.EQ.4) RPMT(NFANO)=RPMT(NCC)
      WATE(NCC)=WATE(NCC)+GBWT
      IF (ISIC) GBWTS=GBWT*CONVER(3)
      IF (IOUTCD.GT.1) WRITE (10,380) GBWT
      IF (ISIO.AND.ICUTCD.GT.1) WRITE (10,380) GBWTS
      WT1=WT1+GBWT
320  IF (IP.NE.2) RETURN
      IF (ISIO) WT1=WT1*CCNVER(3)
      WRITE (10,390) WT1
      RETURN
C
330  FORMAT (1H /14H *****/14H *          */4H * ,A4,I3,3H *
1/14H *          */13H *****,I1)
340  FORMAT (35H  PR      AD EF      PO      TO      HP)
350  FORMAT (2F8.4,2F8.1,F8.0)
360  FORMAT (29H  HI      HO      WI      CWI )
370  FORMAT (5F8.2,/)
380  FORMAT (/ ,17H GEAR BOX WEIGHT=,3X,F6.2)
390  FORMAT (/ ,26H *****/ TOTAL,15H COMP WEIGHT IS,F10.3)
      END

```

```

C*****
C
C SUBROUTINE (CMECH)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE MECHANICAL DESIGN
C PARAMETERS OF THE COMPRESSORS AND FANS.EI NUMBER
C OF STAGES,RPM,DIAMETER.
C
C CALLING ROUTINES
C -----
C COMPRESSOR
C
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C   IP          ARG          PRINT INDICATOR
C   IDIES       ARG          INPUT INDICATOR
C   NCC         ARG          COMPRESSOR INDICATOR
C   NC          ARG          COMPRESSOR TYPE INDICATOR
C   PR          ARG          PRESSURE RATIO
C   RP1         ARG          PRESSURE IN
C   TI          ARG          TOTAL TEMPERATURE IN
C   TO          ARG          TOTAL TEMPERATURE OUT
C   DFA         ARG          ACTUAL DELTA ENTHALPY
C   DHI         ARG          IDEAL DELTA ENTHALPY
C   H1          ARG          ENTHALPY IN
C   FA          ARG          FUEL AIR RATIO
C   AI          ARG          AREA IN
C   XMC         ARG          MACH NUMBER OUT FOR ROTATING SPLITTERS
C   ARG         ARG          AREA RATIO OUT
C   ARI         ARG          AREA RATIO IN
C   PI          ARG          PRESSURE IN
C   POI         ARG          PRESURE OUT

```

C	WI	ARG	AIRFLOW IN
C	WO	ARG	AIRFLOW OUT
C	XMS	ARG	MACH NUMBER IN
C	XME	ARG	MACH NUMBER OUT
C	PEF	ARG	POLYTROPIC EFFICIENCY
C	ITYPE	ARG	LOCATION INDICATOR FOR DEFAULT
C	NI	ARG	NODE IN
C	NO	ARG	NODE OUT
C	ISTATR		STATOR INDICATOR
C	PRM		FIRST STAGE MAX. PRESSURE RATIO
C	HT		HUB TIP RATIO IN
C	SOLC		SOLIDITY
C	ARIC		BLADE ASPECT RATIO IN
C	AROC		BLADE ASPECT RATIO OUT
C	CCMN		MACH NUMBER OUT
C	TMAXI		MAX. TEMPERATURE IN
C	TMAXO		MAX. TEMPERATURE OUT
C	RPMR		SPEED RATIO NMAX/NDES
C	RHCM		BLADE DENSITY
C	MODE		1 CONSTANT HUB DESIGN COMPRESSOR
C			2 CONSTANT MEAN DESIGN COMPRESSOR
C			3 CONSTANT TIP DESIGN COMPRESSOR
C	SCC		RPM SCALER FOR MATCHING A KNOWN SPEED
C	SN		NUMBER STAGES
C	H2		FIRST STAGE EXIT ENTHALPY
C	PR1		FIRST STAGE PRESSURE RATIO
C	T2		FIRST STAGE EXIT TEMPERATURE
C	RP2		FIRST STAGE EXIT RELATIVE PRESSURE
C	CUTP		CORRECTED TIP SPEED
C	RT		FIRST STAGE TIP RADIUS - FT
C	RPM		RPM OF THE SPOOL
C	DT		FIRST STAGE TIP DIAMETER -IN
C	UTP		FIRST STAGE TIP SPEED
C	NS		NUMBER OF STAGES
C	TR		BLADE TAPER RATIO
C	CLP		COMPRESSOR LOADING
C	FMEAN		MEAN RADIUS
C	RTB		BLADE TIP RADIUS
C	RHB		BLADE HUB RADIUS
C	RTFR		FRONT FRAME RADIUS
C	DELMNS		DELTA MACH NUMBER
C	DELAR		DELTA ASPECT RATIO
C	DFAS		DELTA ENTHALPY STAGE
C	DELARI		DELTA AREA RATIO
C	POS		PRESSURE INTO/OUTOF STAGE
C	EF		POLYTROPIC EFFICIENCY
C	TTOS		TEMPERATURE INTO/OUTOF STAGE
C	DELTM		DELTA MAX. TEMPERATURE
C	HOS		ENTHALPY INTO/OUTOF STAGE
C	XMCS		MACH NUMBER INTO/OUTOF STAGE
C	AR		ASPECT RATIO OF STAGE
C	ARII		AREA RATIO OF STAGE
C	HIS		ENTHALPY INTO STAGE
C	TTIS		TEMPERATURE INTO STAGE
C	PIS		PRESSURE INTO STAGE
C	CW		CORRECTED AIRFLOW IN TO STAGE


```

C  BH          BLADE HEIGHT - FT
C  NB          NUMBER OF BLADES
C  RTBA        TIP RADIUS OF BLADE
C  RTHBA       HUB RADIUS OF BLADE
C  BHAI        BLADE HEIGHT
C  HTI         HUB/TIP OF BLADE
C  TSTRE       TOTAL TEMPERATURE FOR STRESS CALCULATION
C  RHCB        DENSITY OF BLADE MATERIAL
C  UTP1        BLADE TIP SPEED
C  BLN         NUMBER OF BLADES IN REAL NUMBER
C  RHOD        DENSITY OF DISK MATERIAL
C  WT          STAGE WEIGHT
C  CL          STAGE LENGTH
C  WATE        COMPRESSOR TOTAL WEIGHT
C  ALENG       COMPRESSOR TOTAL LENGHT
C  RI          INNER RADIUS - IN
C  RO          OUTER RADIUS - IN

```

```

C
C *****

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```

      SUBROUTINE CMECH (IP,IDES,NCC,NC,PR,RPI,TI,TO,DHA,DHI,H1,FA,AI,XMO
1,ARO,ARI,PI,POI,WI,WO,XMS,XME,PEF,ITYPE,NI,NO)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
      DIMENSION PRR(9), UTIP(9), PRS(20)

```

```

C
C          *****
C          * COMMON BLOCKS *
C          *****
C

```

```

      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTCL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
1C(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO

```

```

C
C          *****
C          * DATA STATEMENTS *
C          *****
C

```

```

      DATA TSTD,PSTD,PIE/518.67,2116.22,3.14159/
      DATA PRR/1.,1.18,1.36,1.43,1.503,1.581,1.667,1.775,1.9/
      DATA UTIP/600.,885.,1100.,1200.,1300.,1400.,1500.,1600.,1700./
      WTRF=0.
      WTRF=0.
      CIMN=XMS
      ISTATR=IWMEC(2,NCC)

```

```

10    GO TO (10,20),IDES
      PRM=DESVAL(2,NCC)
      HT=DESVAL(3,NCC)
      SOLC=DESVAL(4,NCC)
      ARIC=DESVAL(5,NCC)
      AROC=DESVAL(6,NCC)
      COMN=DESVAL(7,NCC)
      IF (ITYPE.EQ.4) COMN=XMO
      TMAXI=DESVAL(8,NCC)
      TMAXO=DESVAL(9,NCC)
      RPMR=DESVAL(10,NCC)
      RHOM=DESVAL(11,NCC)
      MODE=IFIX(DESVAL(12,NCC)+.01)
      SCC=DESVAL(13,NCC)
      TMET=DESVAL(14,NCC)
      GO TO 30
20    PRM=DEFAULT(2,ITYPE)
      HT=DEFAULT(3,ITYPE)
      SOLC=DEFAULT(4,ITYPE)
      ARIC=DEFAULT(5,ITYPE)
      ARCC=DEFAULT(6,ITYPE)
      COMN=DEFAULT(7,ITYPE)
      IF (ITYPE.EQ.4) COMN=XMO
      TMAXI=DEFAULT(8,ITYPE)
      TMAXO=DEFAULT(9,ITYPE)
      RPMR=DEFAULT(10,ITYPE)
      RHOM=DEFAULT(11,ITYPE)
      MODE=IFIX(DEFAULT(12,ITYPE)+.01)
      SCC=DEFAULT(13,ITYPE)
      TMET=DEFAULT(14,ITYPE)
30    IF (.NOT.ISII) GO TO 40
      TMET=TMET/CONVER(8)
      TMAXO=TMAXO/CONVER(8)
      TMAXI=TMAXI/CONVER(8)
      RHCM=RHCM/CONVER(5)
C
C FOR DESIGN CASE: CALCULATE NUMBER OF STAGES BASED ON ENTHALPY
C CHANGE PER STAGE AND MAXIMUM PRESSURE RATIO
C
40    IFLAG=1
      XME=CCMN
      SN=0.
      PR1=PR
50    SN=SN+1.
      IF (SN.GT.20.) WRITE (10,220) NCC
      IF (SN.GT.20.) GO TO 80
C
C CALCULATE PRESSURE RATIO (PR1) ACROSS THE COMPONENT
C
      IF (IWMEC(7,NCC).NE.0) SN=IWMEC(7,NCC)
      H2=H1+DHI/SN
      T2=STHERM(1,H2,FA)
      RP2=STHERM(2,T2,FA)
      PR1=RP2/PR1
      IF (IWMEC(7,NCC).NE.0) GO TO 80
      IF (PR1.GT.PRM) GO TO 50

```

```

C
C CALCULATE CORRECTED TIP SPEED (CUTP), TIP
C RADIUS (RT), CORRECTED ROTOR SPEED (CRPM), AND ROTOR SPEED (RPM)
C
      NOUT=KINDS(11,1)+1
      DO 60 I=2,NOUT
      NT=KINDS(11,I)
      DO 60 J=2,4
      N1=JCONF(NT,J-1)
      N2=JCONF(NT,J)
      IF (N2.EQ.NCC) GO TO 70
60    CONTINUE
      GO TO 80
70    RPM=RPMT(N1)
      RPMT(NCC)=RPM
      RT=SQRT(AI/PIE/(1.-HT**2))
      CRPM=RPM/SQRT(TI/TSTD)
      CUTP=CRPM/60.*2.*RT*PIE
      GO TO 110
80    DO 90 I=2,9
      IF (PRI.LT.PRR(I)) GO TO 100
90    CONTINUE
      I=9
100   DX=PRR(I)-PRR(I-1)
      DY=UTIP(I)-UTIP(I-1)
      CUTP=(DY/DX*(PRI-PRR(I-1))+UTIP(I-1))*SCC
      RT=SQRT(AI/PIE/(1.-HT*HT))
      CRPM=CUTP*60./(2.*RT*PIE)
      RPM=CRPM*SQRT(TI/TSTD)
      RPMT(NCC)=RPM
C
C CALCULATE TIP DIAMETER (DT) IN INCHES, TIP SPEED (UTP),
C AND NUMBER OF STAGES (NS)
C
110   DT=RT*24.
      UTP=CUTP*SQRT(TI/TSTD)
      NS=IFIX(SN+.01)
      SND=SN
C
C INITIALIZE BLADE TAPER RATIO (TR) AND CALCULATE BLADE STRESS (ST)
C AND LOADING PARAMETER (CLP)
C
      TR=1.8
      IF (NC.EQ.3) TR=1.2
      RHO1=RHOM
      CALL STRESS (RT,TI,UTP,HT,RPM,ST,TR,NC,IP,RHO1,TMET)
      CLP=200412./UTP*(H2-H1)/UTP/((HT+1.))**2
C
C CHECK FOR PRINT FORMAT
C
      IF (IP.NE.2) GO TO 130
C
C WRITE COMPRESSOR DESIGN DATA
C
      WRITE (10,230) NCC
      WRITE (10,240)

```

```

      IF (ISIO) GO TO 120
      WRITE (10,250) CLP,SN,DT,CUTP,RPM,CRPM
      GO TO 130
120    SDT=DT*CONVER(1)
      SCUTP=CUTP*CONVER(2)
      WRITE (10,250) CLP,SN,SDT,SCUTP,RPM,CRPM
130    RMEAN=RT*SQRT(0.5*(1.+HT*HT))
      RTB=RT
      RHB=RTB*HT
      RTFR=RT*12.
      WTFF=0.
      IF (IWMEC(3,NCC).NE.0.) CALL FRAME (RTFR,IWMEC(3,NCC),WTFF,IP)
      RO(1,NI)=RTFR
      RI(1,NI)=RHB*12.
      DELMNS=(CIMN-CGMN)
      IF (DELMNS.NE.0.) DELMNS=DELMNS/SN
      DELAR=ARIC-ARCC
      IF (SN.GT.1.) DELAR=DELAR/(SN-1.)
      DHAS=DHA/SN
      DELARI=ARI-ARO
      IF (DELARI.NE.0.) DELARI=DELARI/SN
C
C INITIALIZE DESIGN VALUES FOR STAGE-BY-STAGE COMPRESSOR DESIGN
C
      WT=0.
      CL=0.
      POS=PI
      EF=-PEF
      TTOS=TI
      DELTM=(TMAXO-TMAXI)/SN
      HOS=H1
      XMCS=CIMN+DELMNS
      AR=ARIC+DELAR
      ARII=ARI+DELARI
      NSTAG(NCC)=NS
      NST=NS+1
C
C BEGIN STAGE-BY-STAGE COMPRESSOR DESIGN
C
      DO 190 I=1,NST
C
C INITIALIZE STAGE INLET VALUES: MACH (XMCS), ENTHALPY (HIS), TOTAL
C TEMPERATURE (TTIS), TOTAL PRESSURE (PIS) AND ASPECT RATIO (AR)
C
      XMCS=XMCS-DELMNS
      IF (XMCS.LE.0.) GO TO 210
      HIS=HOS
      TTIS=TTOS
      PIS=POS
      ARII=ARII-DELARI
      IF (AR.NE.0.) AR=AR-DELAR
C
C
C CALCULATE STAGE INLET GAMMA (GA), STAGE EXIT ENTHALPY (HOS) AND
C TOTAL TEMPERATURE (TTOS)
C

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```

      GA=STHERM(5,TTIS,FA)
      HOS=HIS+DHAS
      TTOS=STHERM(1,HOS,FA)
C
C CALCULATE AVERAGE TOTAL TEMPERATURE (TGAM), GAMMA (GAV) AND PRESSURE
C RATIO (PRS) ACROSS THE STAGE AND STAGE EXIT TOTAL PRESSURE (POS)
C
      TGAM=(TTIS+TTOS)/2.
      GAV=STHERM(5,TGAM,FA)
      TOS1=EF*ALOG(TTOS/TTIS)
      TOS2=EXP(TOS1)
      PRS(I)=TOS2**((GAV/(GAV-1.))
      POS=PIS*PRS(I)
C
C CALCULATE STAGE INLET CORRECTED FLOW (CW) AND STAGE INLET AREA (A1C)
C
      W1=W1
      CW=W1*SQRT(TTIS/TSTD)/PIS*PSTD
      A1C=0.
      CALL DUCT1 (TTIS,PIS,W1,GA,XMCS,A1C)
      GO TO (140,150,160),MODE
C
C CALCULATE RTB FOR CONSTANT HUB
C
140   RTB=SQRT(RHB*RHB+A1C/PIE)
      GO TO 170
C
C CHECK FOR MEANINGLESS STAGE AND BLADE PARAMETEPS. CALCULATE BLADE
C HEIGHT (BH) AND NUMBER OF BLADES (NB)
C
150   CHECKA=RMEAN*RMEAN-A1C/(2.*PIE)
      IF (CHECKA.LE.0.) GO TO 210
      RTB=SQRT(RMEAN*RMEAN+A1C/(2.*PIE))
      RHB=SQRT(CHECKA)
      GO TO 170
C
C CALCULATE RHB FOR CONSTANT TIP
C
160   RHB=RTB*RTB-A1C/PIE
      IF (RHB.LE.0.) GO TO 210
      RHB=SQRT(RHB)
170   BH=RTB-RHB
      NB=IFIX(PIE*2.*RTB*SOLC*AR/BH)
C
C CALCULATE BLADE TIP RADIUS (RTBA), HUB RADIUS (RHBA) AND HEIGHT
C (BHAI) IN INCHES
C
      RTBA=RTB*12.
      RHBA=RHB*12.
      IF (I.GE.NST) GO TO 190
      BHAI=BH*12.
      HT1=RHBA/RTBA
C
C CALCULATE BLADE TIP SPEED (UTP1) AND STRESS (ST1)
C
      IF (TMAXO.EQ.0.) TSTRES=TTIS

```

```

      IF (TMAXO.NE.0..AND.I.EQ.1) TSTRES=TMAXI-DELTM
      IF (TMAXO.NE.0.) TSTRES=TSTRES+DELTM
      RHOB=RHQM
      UTP1=RPM*2.*PIE/60.*RTB
      UTIP1=UTP1
      IF (RPMR.NE.0.) UTIP1=UTIP1*RPMR
      CALL STRESS (RTB,TSTRES,UTIP1,HT1,RPM,ST1,TR,NC,0,RHOB,TMET)
      BLN=FLOAT(NB)

C
C CALCULATE STAGE WEIGHT (WTT) AND LENGTH (CLT) AND TOTAL COMPONENT
C WEIGHT (WT) AND LENGTH (CL)
C
      RHOD=.168
      IF (TSTRES.GT.TMET) RHOD=.286
      RM=0.
      IF (ITYPE.EQ.4) RM=SQRT(RTBA**2-ARII*(RTBA**2-RHBA**2))
      IF (ITYPE.EQ.4) ST1=ST1+2.*PIE/BLN*RHOB*(RM/RTBA)**2*UTIP1**2
      IF (IP.EQ.2) WRITE (10,300) I
      CALL CWT (AR,BHAI,RHOB,RHOD,NB,ST1,RHBA,WTT,CLT,NC,I,ISTATR,HT1,RM
1)
      IF (IP.EQ.2) WRITE (10,280)
      WT=WT+WTT
      CL=CL+CLT
      IF (IP.NE.2) GO TO 190
      IF (ISIO) GO TO 180
      WRITE (10,290) PRS(1),DHAS,XMCS,A1C,RHBA,RTBA,NB,UTP1,ST1,WTT,TTIS
      GO TO 190
180  SDP=DHAS*CONVER(9)
      SAI=A1C*CONVER(4)
      SRTB=RTBA*CONVER(1)
      SRHB=RHBA*CONVER(1)
      SUTP=UTP1*CONVER(2)
      SST=ST1*CONVER(6)
      SWT=WTT*CONVER(3)
      STTI=TTIS*CONVER(8)
      WRITE (10,290) PRS(1),SDH,XMCS,SAI,SRHB,SRTB,NB,SUTP,SST,SWT,STTI
190  CONTINUE
      WTFR=0.
      IF (IWMEC(4,NCC).NE.0) CALL FRAME (RTBA,IWMEC(4,NCC),WTFR,IP)
      WT=WT+WTFR+WTFE
      RF=0.
      FF=0.
      IF (IWMEC(3,NCC).NE.0) FF=CL/(2.*NS)
      IF (IWMEC(4,NCC).NE.0) RF=CL/NS
      CL=CL+FF+RF
      WATE(NCC)=WT
      ALENG(NCC)=CL
      RI(2,NO)=RHBA
      RO(2,NO)=RTBA
      IF (IP.NE.2) RETURN

C
C WRITE TOTAL COMPONENT WEIGHT AND LENGTH
C
      WRITE (10,260)
      IF (ISIO) GO TO 200
      WRITE (10,270) NS,WT,CL

```

```

      RETURN
200   SWT=WT*CONVER(3)
      SCL=CL*CONVER(1)
      WRITE (10,270) NS,SWT,SCL
      RETURN
210   WRITE (10,310) NCC
      RETURN
C
220   FORMAT (11H COMPRESSOR,I3,28H PRESSURE RATIO IS TOO HIGH )
230   FORMAT (12H COMPRESSOR,I3,19H MECHANICAL DESIGN ,/)
240   FORMAT (49H LOADING  N STG  DIAM  U TIP C    RPM  C RPM )
250   FORMAT (F9.3,2F8.2,3F8.1)
260   FORMAT (/,24H  N STG  WEIGHT  LENGTH )
270   FORMAT (I6,F9.2,F8.2,/)
280   FORMAT (42H  PR DEL H  MACH  AREA  R HUB  R TIP  NB,26H U TIP
1 STR  WEIGHT TIN)
290   FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F6.0)
300   FORMAT (/,7H STAGE ,I4)
310   FORMAT (11H COMPRESSOR,I3,28H  STAGE AND BLADE PARAMETERS,13H MEAN
1INGLESS )
      END

```

```

C*****
C
C  SUBROUTINE(CWT)
C  -----
C
C  PURPOSE
C  -----
C  THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C  OF FANS AND COMPRESSORS.
C
C
C  CALLING ROUTINES
C  -----
C
C
C  REQUIRED SUBROUTINES
C  -----
C
C
C  MODIFICATION HISTORY
C  -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C  AUTHOR/LANGUAGE/DATE
C  -----
C    E. DNAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C  GLOSSARY
C  -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C    AR          ARG          ASPECT RATIO
C    BH          ARG          BLADE HEIGHT
C    RHOB        ARG          BLADE DENSITY
C    RHOD        ARG          DISK DENSITY
C    NB          ARG          NUMBER OF BLADES
C    ST          ARG          BLADE ROOT STRESS
C    RHB         ARG          BLADE HUB RADIUS
C    WT          ARG          STAGE WEIGHT
C    CL          ARG          STAGE LENGTH
C    NC          ARG          COMPONENT TYPE
C    I           ARG          STAGE NUMBER
C    NST         ARG          STATOR INDICATOR
C    HTR         ARG          HUB-TIP RATIO
C    RM          ARG          SPLITTER RADIUS
C    VB          ARG          BLADE VOLUME
C    SF          ARG          STRESS FACTOR
C    VD          ARG          DISK VOLUME
C    WTD         ARG          DISK WEIGHT

```



```

C   WTB          BLADE WEIGHT
C   WTS          STATOR WEIGHT
C   WTNB         NUTS AND BLOTS WEIGHT
C   WTCASE       CASE WEIGHT
C
C
C *****
C
C CALCULATE TOTAL BLADE AND STATOR WEIGHT
C
C   SUBROUTINE CWT (AR,BH,RHOB,RHOD,NB,ST,RHB,WT,CL,NC,I,NST,HTR,RM)
C   REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C   1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C           *****
C           * COMMON BLOCKS *
C           *****
C
C   COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C   140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
C   2T,DEPV(20),DTOL(20),PERPF(20)
C   COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
C   1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C   2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C   3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
C   COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C   1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
C   2UTCD,NSTAG(60)
C   COMMON /CONVER/ CONVER(15)
C   COMMON /DEFAULT/ DEFAULT(15,20)
C   LOGICAL IWT,IPLT,IERR,ISII,ISIO
C   IF (I.NE.1) GO TO 10
C
C CALCULATE STAGE LENGTH AND BLADE AND STATOR WEIGHT
C
C   RHI=RHB
C   CL=2.*BH/AR
C   XCL=.17*CL
C   IF (NST.GT.0) CL=XCL+CL
C   IF (NST.LE.0) CL=CL/2.
C   VB=.12*BH**3/AR**2
C   IF (NC.EQ.1) VB=.055*BH**3/AR**2
C   IF (HTR.GT..8) VB=(1.2+(HTR-.8)*4.)*.1*BH**3/AR**2
C   BN=NB
C   WTB=VB*RHOB*NB+.2*3.1415*BH**2/AR**2*RHCB*RM
C   WTS=WTB
C
C CALCULATE DISK WEIGHT
C
C   SF=ST*RHB/100000.
C   IF (RHOD.GT..2) GO TO 30
C   VD=(.11+(.00789*SF))* (RHB*2. )**2
C   IF (SF.GT..4) VD=(.16262-.2138542*SF+.23954613*SF**2-.03515625*SF*
C   1*3)*(RHB*2. )**2
C   IF (SF.GT.2.4) VD=(-.2326+.3199*SF)*(RHB*2. )**2
C   IF (NC.EQ.1.AND.I.GT.3) GO TO 20

```

```

      IF(NC.EQ.1)VD=(.11+.4496*SF)*(RHB*2.)**2
      IF (NC.EQ.1.AND.SF.GT.2.4.AND.SF.LT.5.2) VD=(.9458+.1014*SF)*(RHB*
20      GO TO 40
30      VD=(.11+.003875*SF)*(RHB*2.)**2
      IF (SF.GT..8) VD=(.172121-.1543155*SF+.10808*SF**2-.0090774*SF**3)
1*(RHB*2.)**2
      IF (SF.GT.4.) VD=(-.5015+.3*SF)*(RHB*2.)**2
40      WTD=VD*RHOD
      WTNB=(RHI*.75)*2.*3.1416*.075*CL*.286*RHI
      IF (NC.EQ.1.AND.I.EQ.1) WTNB=0.
      IF (NST.LE.0) WTS=0.
      WTCASE=(RHB+BH)*2.*3.1416*CL*.1*.286
      WT=WTD+WTS+WTB+WTNB+WTCASE
      IF (IOUTCD.NE.2) RETURN
      IF (ISIC) GO TO 50
      WRITE (10,60)
      WRITE (10,70) WTD,WTB,WTS,WTNB,WTCASE,CL,RHOB,RHOD,AR
      RETURN
50      WTD=WTD*CONVER(3)
      WTS=WTS*CONVER(3)
      WTB=WTB*CONVER(3)
      WTNB=WTNB*CONVER(3)
      WTCASE=WTCASE*CONVER(3)
      SCL=CL*CONVER(1)
      SRHOB=RHOB*CONVER(5)
      SRHOD=RHOD*CONVER(5)
      WRITE (10,60)
      WRITE (10,80) WTD,WTB,WTS,WTNB,WTCASE,SCL,SRHOB,SRHOD,AR
      RETURN
C
60      FORMAT (48H  WD  WB  WS  WN  WC  CL  RHOB  RHOD  AR)
70      FORMAT (5F5.0,F6.1,F6.3,F6.3,F6.2)
80      FORMAT (5F5.1,F6.3,2F6.5,F6.2)
      END

```

```

C*****
C
C SUBROUTINE(COMBWT)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF PRIMARY BURNERS, DUCT BURNERS AND AUGMENTERS.
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C      NAME      CRIGIN      USAGE      DISCRIPTION
C      -----
C   ICOMP      ARG      I/O      COMPONENT NUMBER
C   ITYPE
C   VR          THROUGH FLOW VELOCITY
C   TR          RESENDENCY TIME
C   WC          CORRECTED AIRFLOW
C   PO          PRESSURE IN
C   TC          TEMPERATURE IN
C   FA          F/A RATIO IN
C   DM          MEAN DIAMETER IN IN
C   RTR         REF TIP RADIUS FOR DM
C   RHR         REF HUB RADIUS FOR DM
C   GAMB        GAMMA
C   AMACH       MACH NUMBER
C   WSP         FLOW PER UNIT AREA
C   R           HUB TIP RATIO
C   Dh          INNER DIAMETER
C   DT          OUTER DIAMETER
C   RT          OUTER RADIUS

```

```

C RH INNER RADIUS
C BLEN LENGTH
C WTCASE OUTER CASE WEIGHT
C WTLIN LINNER WEIGHT
C NN NUMBER OF FUEL NOZZLES
C WTN FUEL NOZZLE WEIGHT
C WTCAS INNER CASE WEIGHT
C WTOT TOTAL WEIGHT
C
C
C *****
C
C SUBROUTINE COMBWT (ICOMP)
C REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C 1R,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C *****
C * COMMON BLOCKS *
C *****
C
C COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C 140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TCLT,TOLTT
C 2T,DEPV(20),DTOL(20),PERPF(20)
C COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
C 1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C 2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C 3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
C COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C 10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
C 2UTCD,NSTAG(60)
C COMMON /CONVER/ CONVER(15)
C COMMON /DEFAULT/ DEFAULT(15,20)
C LOGICAL IWT,IPLT,IERR,ISII,ISIO
C DATA LPBUR,LAUG/4HPBUR,4HAUG /
C IF (IOUTCD.GT.1) WRITE (10,120) IWMEC(1,ICOMP),ICOMP,IOUTCD
C
C INITIALIZE INPUTS
C
C ITYPE=11
C IF (IWMEC(1,ICOMP).EQ.LPBUR) ITYPE=10
C IF (IWMEC(1,ICOMP).EQ.LAUG) ITYPE=13
C VR=DEFAULT(1,ITYPE)
C TR=DEFAULT(2,ITYPE)
C IDES=1
C IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
C IF (IDES.EQ.2) GO TO 10
C VR=DESVAL(1,ICOMP)
C TR=DESVAL(2,ICOMP)
10 NODEI=JCONF(ICOMP,1)
C NODEO=JCONF(ICOMP,3)
C WC=CCRFLC(NODEI)
C WC=WC/1.54972555
C PO=TOPRES(NODEI)
C PO=PO*144.
C TO=TOTEMP(NODEI)
C FA=FAR(NODEI)

```

```

DM=0.
IF (ITYPE.EQ.13) GO TO 60
IF (DEFAULT(3,ITYPE).NE.0.) DM=2.*DEFAULT(3,ITYPE)
IF (DESVAL(3,ICOMP).NE.0.) DM=2.*DESVAL(3,ICOMP)
IF (ISII) DM=DM/CONVER(1)
IF (IDES.EQ.1.AND.DESVAL(4,ICOMP).EQ.0..AND.DESVAL(3,ICOMP).EQ.0.)
1 NDI=NODEI
IF (IDES.EQ.1.AND.DESVAL(4,ICOMP).EQ.0..AND.DESVAL(3,ICOMP).EQ.0.)
1 GO TO 40
IF (IDES.EQ.2.AND.DEFAULT(4,ITYPE).EQ.0..AND.DEFAULT(3,ITYPE).EQ.0.)
1 NDI=NODEI
IF (IDES.EQ.2.AND.DEFAULT(4,ITYPE).EQ.0..AND.DEFAULT(3,ITYPE).EQ.0.)
1 GO TO 40
IF (DESVAL(4,ICOMP).NE.0.) GO TO 30
IF (DEFAULT(4,ITYPE).NE.0.) GO TO 20
GO TO 50
20 IDI=IFIX(DEFAULT(4,ITYPE)+.01)
NDI=JCONF(IDI,3)
GO TO 40
30 IDI=IFIX(DESVAL(4,ICOMP)+.01)
NDI=JCONF(IDI,3)
40 RTR=RO(2,NDI)
RHR=RI(2,NDI)
DM=RTR+RHR
50 DM=DM/12.
60 IF (ISII) VR=VR/CONVER(2)
C
C CALCULATE MACH NUMBER AND FLOW PER UNIT AREA
C
C
GAMB=STHERM(5,TO,FA)
AMACH=VR/SQRT(GAMB*32.17*53.3*TO-(GAMB-1.)/2.*VR**2)
WSP=PO*AMACH*SQRT(GAMB/(53.3*TO)*32.2)*(1./(1.+(GAMB-1.)/2.*AMACH*
1*2))**((GAMB+1.)/2./(GAMB-1.))
WSP=WSP*2116.22/PO*SQRT(TO/518.67)
IF (ITYPE.EQ.13) GO TO 70
C
C CALCULATE BURNER DIMENSIONS
C
C
R=(1.-2.*WC/WSP/3.1415/DM**2)
IF (R.LE.0.) R=0.
R=SQRT(R)
DH=R*DM*12.
70 IF (ITYPE.EQ.13) DH=0.
DT=SQRT(DH**2/144.+4.*WC/WSP/3.1415)*12.
RT=DT/2.
RH=DH/2.
BLEN=VR*TR*12.
C
C CALCULATE WEIGHT
C
C
WTCASE=3.1415*PO/144.*DT**2*BLEN*.3/166000.
WTLIN=.055*3.1415*BLEN*.3*(DH+DT)
NN=IFIX(3.1415*(DT+DH)/(.6*(DT-DH)))
WTN=.009*BLEN*3.1415/4.*((DT-DH)**2/4.*.3*NN
WTICAS=3.1415*PO/144.*DT*BLEN*.3*DH/166000.

```

```

      WTOT=WTCASE+WTLIN+WTN+WTICAS
C
C  CALCULATE FRAME WEIGHT FOR PRI BURNERS
C
      WTFRAM=0.
      IF (ITYPE.EQ.10.AND.IWMEC(2,ICOMP).EQ.1) CALL FRAME (RT,4,WTFRAM,0
1)
      WTOT=WTOT+WTFRAM
C
C  STORE OUTPUT
C
      WATE(ICOMP)=WTOT
      ALENG(ICOMP)=BLEN
      RI(1,NODEI)=RH
      PO(1,NODEI)=RT
      RI(2,NODEO)=RH
      RO(2,NODEO)=RT
C
C  WRITE OUTPUT
C
      IF (ISIC.AND.IOUTCD.EQ.2) GO TO 90
      IF (IOUTCD.NE.2) RETURN
      IF (ITYPE.NE.10) GO TO 80
      WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,130) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,170) WTCASE,WTLIN,WTN,WTICAS,WTFRAM,WTOT
      GO TO 110
80  WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,130) RH,RT,BLEN,AMACH,WSP
      WRITE (10,190)
      WRITE (10,200) WTCASE,WTLIN,WTN,WTICAS,WTOT
      GO TO 110
90  RT=RT*CCNVER(1)
      RH=RH*CCNVER(1)
      WSP=WSP*CONVER(7)
      WTLIN=WTLIN*CONVER(3)
      WTN=WTN*CONVER(3)
      WTICAS=WTICAS*CONVER(3)
      WTFRAM=WTFRAM*CONVER(3)
      WTOT=WTOT*CONVER(3)
      WTCASE=WTCASE*CONVER(3)
      IF (ITYPE.NE.10) GO TO 100
      WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,140) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,170) WTCASE,WTLIN,WTN,WTICAS,WTFRAM,WTOT
      GO TO 110
100 WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,140) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,200) WTCASE,WTLIN,WTN,WTICAS,WTOT

```

```

110  RETURN
C
120  FORMAT (1H /14H *****/14H *          */4H * ,A4,I3,3H *
1/14H *          */13H *****,I1)
130  FORMAT (5F9.3)
140  FORMAT (5F9.3)
150  FORMAT (15H BURNER NUMBER I4)
160  FORMAT (53H  CAS WT  LIN WT  NOZ WT  INC WT  FRAME  WTOT)
170  FORMAT (6F9.1,/)
180  FORMAT (44H  RIN  ROUT  LENGTH  MACH  WSPEC)
190  FORMAT (43H  CAS WT  LIN WT  NOZ WT  INC WT  WTOT)
200  FORMAT (6F9.1,/)
      END

```

```

C*****
C
C SUBROUTINE(DUCTWT)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF THE DUCTS.
C
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C      ICOMP      ARG          I/O          COMPONENT NUMBER
C      NODEI                      NODE IN
C      NODEO                      NODE OUT
C      TLH                      LENGTH TO HEIGHT RATIO
C      AM                      MACH NUMBER IN
C      NODER                      REF COMPONENT NUMBER FOR DM
C      RHR                      REF HUB RADIUS
C      RTR                      REF TIP RADIUS
C      WA                      AIRFLOW
C      PO                      PRESSURE IN
C      TO                      TEMPERATURE IN
C      FAI                      F/A RATIO IN
C      DM                      MEAN DIAMETER IN IN
C      GAMB                      GAMMA
C      RHO                      MATERIAL DENSITY
C      STR                      REF STRESS
C      R                      HUB TIP RATIO
C      DH                      INNER DIAMETER

```



```

C   DT                                OUTER DIAMETER
C   RT                                OUTER RADIUS
C   RH                                INNER RADIUS
C   BLENG                             LENGTH
C   WTCASE                            OUTER DUCT WEIGHT
C   WTICAS                            INNER DUCT WEIGHT
C   WTOT                              TOTAL WEIGHT
C
C
C*****
C
      SUBROUTINE DUCTW (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERROR,
      1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
      2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,130) IWMEC(1,ICOMP),ICOMP,IOUTCD
      NODEI=JCONF(ICOMP,1)
      NODEO=JCONF(ICOMP,3)
      TLH=0.
      IF (IWMEC(2,ICOMP).EQ.1) GO TO 10
      IF (IWMEC(2,ICOMP).EQ.2) GO TO 20
      GO TO 40
10    WATE(ICOMP)=0.
      ALENG(ICOMP)=0.
      RO(1,NODEI)=RO(2,NODEI)
      RI(1,NODEI)=RI(2,NODEI)
      RO(2,NODEO)=RO(2,NODEI)
      RI(2,NODEO)=RI(2,NODEI)
      RETURN
20    IF (DESVAL(2,ICOMP).EQ.0.) GO TO 30
      TLH=DESVAL(2,ICOMP)
      GO TO 50
30    TLH=DEFAULT(2,12)
      GO TO 50
40    BLEN=TLENG(NODEO)-TLENG(NODEI)
50    IF (DESVAL(1,ICOMP).EQ.0.) GO TO 70
      AM=DESVAL(1,ICOMP)
      IF (DESVAL(4,ICOMP).LT.0.) NODER=JCONF(ICOMP,1)
      IF (DESVAL(4,ICOMP).LT.0.) GO TO 90

```

```

      IF (DESVAL(3,ICOMP).EQ.0..AND.DESVAL(4,ICOMP).NE.0.) GO TO 60
      DM=2.*DESVAL(3,ICOMP)/12.
      IF (ISII) DM=DM/CONVER(1)
      GO TO 100
60     NODER=IFIX(DESVAL(4,ICOMP)+.01)
      GO TO 90
70     AM=DEFAULT(4,12)
      IF (DEFAULT(4,12).LT.0.) NODER=JCONF(ICOMP,1)
      IF (DEFAULT(4,12).LT.0.) GO TO 90
      IF (DEFAULT(3,12).EQ.0..AND.DEFAULT(4,12).NE.0.) GO TO 80
      DM=2.*DEFAULT(3,12)/12.
      IF (ISII) DM=DM/CONVER(1)
      GO TO 100
80     NODER=IFIX(DEFAULT(4,12)+.01)
90     RHR=PI(2,NODER)
      RTR=RO(2,NODER)
      DM=(RHR+RTR)/12.
100    WA=WTF(NODEI)
      PO=TOPRES(NODEI)
      PO=PO*144.
      TO=TOTEMP(NODEI)
      FAI=FAR(NODEI)
      GAMB=STHERM(5,TO,FAI)
      AD=0.DO
      CALL DUCT1 (TO,PO,WA,GAMB,AM,AD)
      R=0.
      IF (DM.NE.0.) R=(1.-2.*AD/3.1415/DM**2)
      IF (R.LE.0.) R=0.
      R=SQRT(R)
      DH=R*DM*12.
      DT=SQRT(DH**2/144.+4.*AD/3.1415)*12.
      IF (TLH.NE.0.) BLEN=TLH*(DT-DH)/2.
      RHO=.168
      STR=50000.
      IF (TO.GT.1160.) RHO=.286
      IF (TO.GT.1160.) STR=70000.
      WTCASE=3.1415*PO/144.*DT**2*BLEN*RHO/(2.*STR)
      WTICAS=3.1415*PO/144.*DT*BLEN*DH*RHO/(2.*STR)
      WTOT=WTCASE+WTICAS
      RH=DH/2.
      RT=DT/2.
      WATE(ICOMP)=WTOT
      ALENG(ICOMP)=BLEN
      RO(1,NODEI)=RT
      RI(1,NODEI)=RH
      RO(2,NODEI)=RT
      RI(2,NODEI)=RH
      IF (IQUTCD.NE.2) RETURN
      WRITE (10,210) ICOMP
      IF (ISIG) GO TO 110
      WRITE (10,140) RH,RT,BLEN
      WRITE (10,150) AD,RHO
      WRITE (10,160)
      WRITE (10,200) WTCASE,WTICAS,WTOT
      GO TO 120
110    SRH=RH*CGNVER(1)

```

```

SRT=RT*CONVER(1)
SBLEN=BLEN*CONVER(1)
SAD=AD*CONVER(4)
SRHC=RHG*CONVER(5)
SWTCAS=WTCASE*CONVER(3)
SWTICA=WTICAS*CONVER(3)
SWTOT=WTOT*CONVER(3)
WRITE (10,170) SRH,SRT,SBLEN
WRITE (10,180) SAD,SRHO
WRITE (10,190) SWTCAS,SWTICA,SWTOT
120  RETURN
C
130  FORMAT (1H /14H *****/14H *          */4H * ,A4,I3,3H *
1/14H *          */13H *****,I1)
140  FORMAT (4H RH=,F8.2,4H RT=,F8.2,6H LENG=,F8.2)
150  FORMAT (6H AREA=,F8.3,5H RHO=,F4.3)
160  FORMAT (35H          CAS WT          INC WT          WTOT)
170  FORMAT (4H RH=,F8.4,4H RT=,F8.4,6H LENG=,F8.4)
180  FORMAT (6H AREA=,F8.4,5H RHO=,F8.7)
190  FORMAT (12H OUTER CASE=,F7.4,12H INNER CASE=,F7.4,7H TOTAL=,F7.4)
200  FORMAT (3F13.4,/)
210  FORMAT (7H DUCT ,I4)
END

```

```

C*****
C
C SUBROUTINE(DUCT)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES INLET AND EXIT AREAS
C AND MACH NUMBERS FOR VARIOUS COMPONENTS AND
C THEIR STAGES.
C
C CALLING ROUTINES
C -----
C
C
C REQUIRED SUBROUTINES
C -----
C
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C      TI          ARG          TEMPERATURE IN
C      PI          ARG          PRESSURE IN
C      WI          ARG          AIRFLOW IN
C      A           ARG          MACH NUMBER INPUT
C                               AREA OUTPUT
C      FA          ARG          F/A RATIO
C      XM2         ARG          MACH NUMBER
C      PS          ARG          STATIC PRESSURE
C      Q           ARG          DYNAMIC PRESSURE
C      IP          ARG          PRINT INDICATOR
C      TS          ARG          STATIC TEMPERATURE
C      HI          ARG          ENTHALPY
C      V           ARG          VELOCITY
C
C
C*****
C
C      *****

```

```

C          * COMMON BLOCKS *
C          *****
C
SUBROUTINE DUCT (TI,PI,WI,A,FA,XM2,PS,V,ISIO,IP)
COMMON /CONVER/ CONVER(15)
COMMON /DEFAULT/ DEFAULT(15,20)
LOGICAL ISIO
IF (TI.LT.200.) TI=200.
IF (TI.GT.6000.) TI=6000.

C
C CHECK FOR DUMMY DUCT.  CALCULATE MACH NUMBER (XM2) OR AREA (A)
C
      XM2=A
      IF (A.GT.0.) GO TO 10
      A=0.
      XM2=0.
      V=0.
10     IF (A.EQ.0.) GO TO 20
      GA=STHERM(5,TI,FA)
      CALL DUCT1 (TI,PI,WI,GA,XM2,A)

C
C CALCULATE STATIC TEMPERATURE (TS) AND PRESSURE (PS)
C
      C2=1.+(GA-1.)/2.*XM2*XM2
      TS=TI/C2
      PS=PI/C2**((GA/(GA-1.))

C
C CALCULATE ENTHALPY (HI) AND VELOCITY (V)
C
      HI=STHERM(4,TI,FA)
      IF (TS.GT.TI) TS=TI
      V=SQRT((2.*GA/(GA-1.))*53.34*32.174*(TI-TS))

C
C CALCULATE DYNAMIC PRESSURE (Q)
C
      Q=PS/53.34*V/2.*V/TS/53.34
20     IF (IP.NE.2) RETURN

C
C WRITE DUCT DATA
C
      IF (.NOT.ISIO) GO TO 30.
      VSI=V*CONVER(2)
      TISI=TI/1.8
      PISI=PI*CONVER(11)
      PSSI=PS*CONVER(11)
      ASI=A*CONVER(4)
      WRITE (10,40)
      WRITE (10,50)
      WRITE (10,60) XM2,VSI,TISI,PISI,PSSI,ASI,GA
      RETURN
30     WRITE (10,40)
      WRITE (10,50)
      WRITE (10,60) XM2,V,TI,PI,PS,A,GA
      RETURN

C
40     FORMAT (6H DUCT )

```

```
50  FORMAT (48H  M NO  VEL  T TOT  P TOT  P STAT  AREA  GAM)
60  FORMAT (F6.3,2F6.0,F8.0,F8.0,F10.4,F8.4,/)
    END
```

```

C*****
C
C SUBROUTINE(DUCT1)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE INLET AND EXIT
C AREAS FOR THE STAGE BY STAGE ANALYSIS.
C
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUT-OR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C      T          ARG          TEMPERATURE IN
C      P          ARG          PRESSURE IN
C      W          ARG          AIRFLOW IN
C      A          ARG          AREA IF AREA IS NEGATIVE
C                               MACH IS CALCULATED
C      GA         GAMMA
C      XM         MACH NUMBER
C      PM         FLOW PER UNIT AREA
C      TM         TEST MACH NUMBER
C
C
C*****
C
C
C      SUBROUTINE DUCT1 (T,P,W,GA,XM,A)
C      DATA R,G/53.34,32.174/
C      IF (A.LT.0.) GO TO 10
C      GO TO 30

```

```

C
C CALCULATE MASS FLOW PARAMETER (PM) AND CONSTANTS
C
10    K=0
      A=ABS(A)
      PM=W*SQRT(T)/(P*A)
      XM=PM*20./17.
      CON1=SQRT(GA*G/R)
      GP1=GA+1.
      GM1=GA-1.
C
C FOR OFF-DESIGN CASE: ITERATE TO A MACH NUMBER (XM)
C
20    K=K+1
      CON2=1.+(GM1/2.)*XM*XM
      TM=XM*CON1*CON2**(-GP1/(2.*GM1))
      IF (ABS(PM-TM).LE..0004) RETURN
      IF (K.GT.30) WRITE (10,40)
      IF (K.GT.30) RETURN
      SL=CON1*CON2**(-GP1/(2.*GM1))-XM*XM*(GP1/2.)*CON1*CON2**((-3.*GA+1
1.)/(2.*GM1))
      IF (SL.EQ.0.) RETURN
      XN=XM+((PM-TM)/SL)
      IF (XN.GE.1.) XN=1.
      IF (XN.LE.0.) XN=.001
      IF (XN.EQ..001.AND.XM.EQ..001) RETURN
      IF (XN.EQ.1..AND.XM.EQ.1.) RETURN
      XM=XN
      GO TO 20
C
C FOR DESIGN CASE: CALCULATE AN AREA (A)
C
30    IF (XM.LE.0.) RETURN
      A=W/XM*SQRT(R/GA*G*T)/P*(1.+(GA-1.)/2.*XM*XM)**((GA+1.)/(GA-1.)/2.
1)/G
      RETURN
C
40    FORMAT (25H DUCT IS NOT CONVERGING )
      END

```



```

C*****
C
C SUBROUTINE(EFFD)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CONVERTS ADIABATIC EFFICIENCIES
C TO POLYTROPIC EFFICIENCIES.
C
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C      TI          ARG          TEMPERATURE
C      PR          ARG          PRESSURE RATIO
C      PEFD        ARG          POLYTROPIC EFFICIENCY
C      EF          ARG          ADIABATIC EFFICIENCY
C      FA          ARG          F/A RATIO
C
C*****
C
C THIS ROUTINE CONVERTS ADIABATIC TO POLYTROPIC
C EFFICIENCIES. A (+) DESIGNATES ADIABATIC AND A
C (-) DESIGNATES POLYTROPIC.
C      SUBROUTINE EFFD (TI,PR,PEFD,EF,FA)
C      IF (PR.EQ.1.) RETURN
C      GA=STHERM(5,TI,FA)
C      IF (PR.LE.0.) GO TO 10
C      IF (PEFD.GE.0.) PEFD=ALOG(PR**((GA-1.)/GA))/ALOG(1.+(PR**((GA-1.)/
C 1GA)-1.)/PEFD)
C      IF (PEFD.LE.0.) PEFD=-PEFD
C      EF=(PR**((GA-1.)/GA)-1.)/(PR**((GA-1.)/GA/PEFD)-1.)

```

```

      GO TO 20
10    PR=-1./PR
      IF (PEFD.GE.0.) PEFD=ALOG(1.-PEFD*(1.-PR**((GA-1.)/GA)))/ALOG(PR**
1((GA-1.)/GA))
      IF (PEFD.LE.0.) PEFD=-PEFD
      EF=(1.-PR**((PEFD/GA*(GA-1.)))/(1.-PR**((GA-1.)/GA))
20    PEFD=-PEFD
      RETURN
      END

```

```

C*****
C
C SUBROUTINE(FRAME)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT OF FRONT,
C INTERMEDIATE ,PPIMARY BURNER FRAMES AND TURBINE
C EXIT FRAMES.
C
C CALLING ROUTINES
C -----
C
C
C REQUIRED SUBROUTINES
C -----
C
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C AUTHOR /LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLCSSARY
C -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C      RT          ARG          I          TIP RADIUS
C      NTYPE       ARG          I          TYPE OF FRAME
C      WT          ARG          O          WEIGHT
C      IP          ARG          O          PRINT INDICATOR
C      RT2         L           L          TIP RADIUS SQUARED
C
C
C*****
C
C      SUBROUTINE FRAME (RT,NTYPE,WT,IP)
C      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C      IR,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
C      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(

```

```

140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTOL(20),PERPF(20)
COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
COMMON /CONVER/ CONVER(15)
COMMON /DEFAULT/ DEFAULT(15,20)
LOGICAL IWT,IPLT,IERR,ISII,ISIO
C THIS ROUTINE CALCULATES FRAME WEIGHT
C NTYPE= THE TYPE OF FRAME
C 1 IS FOR SINGLE BEARING FRAME FOR TF OR TJ W/O PT
C 2 IS FOR SINGLE BEARING FRAME FOR SINGLE SPOOL TJ
C 3 IS FOR TURBINE EXIT FRAMES
C 4 IS FOR INTERMEDIATE FRAMES
C
RT2=(RT/12.)*2
GO TO (10,20,30,40),NTYPE
C TYPE 1 FRAME - TJ/TF W/O PTO
10 WT=34.48*RT2
IF (RT2.GT.2.9) WT=47.869*RT2-38.82
GO TO 50
C TYPE 2 FRAME -TJ W PTO
20 WT=104.1*RT2
IF (RT2.GT.1.95) WT=40.99*RT2+123.1
GO TO 50
C TYPE 3 FRAME - TURB EX
30 WT=130.77*RT2
IF (RT2.GT.2.1) WT=49.71*RT2+167.61
GO TO 50
C TYPE 4 FRAME - INTERM W PTO $ TWO BEARINGS
40 WT=130.77*RT2
IF (RT2.GT.5.8) WT=29.02*RT2+567.68
50 IF (IP.NE.2) RETURN
WTT=WT
IF (ISIO) WTT=WTT*CCNVER(3)
WRITE (10,60) WTT
RETURN
C
60 FORMAT (/,12H FRAME WT =,F8.2,/)
END

```

```

C*****
C
C SUBROUTINE(STRESS)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES BLADE ROOT STRESS FOR
C THE COMPRESSORS AND THE TURBINES.
C
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C  -----
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLCSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C  -----
C   RT          ARG          TIP RADIUS
C   TI          ARG          TEMPERATURE IN
C   TS          ARG          TIP SPEED
C   HTR         ARG          HUB-TIP RATIO
C   RPM         ARG          RPM
C   ST          ARG          BLADE ROOT STRESS
C   TR          ARG          BLADE TAPER RATIO
C   NC          ARG          COMPONENT INDICATOR
C   IP          ARG          PRINT INDICATOR
C   RHO         ARG          BLADE DENSITY
C   TMET        ARG          METAL CHANGE TEMP
C   R           HUB-TIP RATIO FOR S
C   A           BASE AREA
C   VAR         CORRECTION FACTOR FOR LOCATION
C   D           CORRECTION FACTOR FOR TAPER RATIO
C   W           WEIGHT PER UNIT AREA
C   F           PULL FORCE
C   XKT         SCALER ON STRESS
C

```

```

C
C*****
C
      SUBROUTINE STRESS (RT, TI, TS, HTR, RPM, ST, TR, NC, IP, RHO, TMET)
      REAL *8DATINP, DATOUT, WTF, TOPRES, TOTEMP, FAR, CORFLO, VMACH, STATP, ERRO
1R, TOL, TOLT, TOLTT, DEPV, DTOL, PERPF
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
      COMMON /DBL/ DATINP(15,60), DATOUT(9,60), WTF(40), TOPRES(40), TOTEMP(
140), FAR(40), COPFLO(40), VMACH(40), STATP(40), ERROR(40), TOL, TOLT, TOLT
2T, DEPV(20), DTOL(20), PERPF(20)
      COMMON /SNGL/ JM1, JM2, JP1, JP2, JCX, LOCTBL(9,60), JCOMP(70), IWAY, NIT,
1ITAB(70), JCONF(60,4), JTYPE(60), JFLOW(70), IDEAP(15), KKINDS(14,25),
2NCOMP, NOSTAT, NITER, NF INIS, NPASS, JCC, NTBL, NCTS, JCIND(20), JCDEP(20),
3JCVIND(20), JCVDEP(20), KDTYP(20), IDONE(60)
      COMMON /WMECH/ IWMEC(7,60), WATE(60), ALENG(60), TLENG(40), RI(2,40), R
1C(2,40), DESVAL(15,60), DSHAF(5), RPMT(60), IWT, IPLT, IERR, ISII, ISIO, IO
2UTCD, NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL ISIO
C THIS ROUTINE CALCULATES THE CENTRIFUGAL ROOT
C STRESS FOR THE FIRST BLADE OF EACH COMPONENT
      IF (TS.EQ.0.) TS=2.*3.1416/60.*RPM*RT
      PCBH=0.
      XKT=1.
      IF (TMET.EQ.0.) TMET=1160.
      IF (RHO.NE.0.) GO TO 10
      DEN=.168
      IF (TI.GT.TMET) DEN=.286
      GO TO 20
10  DEN=RHO
20  R=(1.-PCBH/100.)*HTR+PCBH/100.
      A=1.+(TR-1.)*((1.-R)/(1.-HTR))**2
      VAR=(1.-R)**3/(1.-HTR)**2
      D=(1.-R**2)/2.+(TR-1.)/12.*VAR*(1.+3.*R)
      W=DEN*(1.-R+(TR-1.)/3.*VAR)*RT*12.
      F=DEN/386.*(TS*12.)**2*D
      ST=F/A*XKT
      RHO=DEN
      IF (IP.NE.2) RETURN
      WRITE (10,40)
      IF (ISIO) GO TO 30
      WRITE (10,50) TS, ST, DEN, W, TR, HTR
      RETURN
30  STS=TS*CONVER(2)
      SST=ST*CONVER(6)
      DEN=DEN*CONVER(5)
      W=W*CONVER(7)
      WRITE (10,50) STS, SST, DEN, W, TR, HTR
      RETURN
C
40  FORMAT (45H   U TIP   STRESS      DEN   W/AREA   TR      H/T)
50  FORMAT (2F8.1,4F8.3,/)
      END

```

```

C*****
C
C SUBROUTINE(SHAFT)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT OF THE SHAFTS
C
C
C CALLING ROUTINES
C -----
C
C
C REQUIRED SUBROUTINES
C -----
C
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C -----
C
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C   ICCMP      ARG      I/O      COMPONENT NUMBER
C   POWER      HORSEPOWER
C   NT      TURBINE COUNTER
C   NTURB      TURBINE NUMBER FOR POWER SUMMATION
C   NCOM      COMPRESSOR NUMBER FOR LENGTH
C   TLEN      SHAFT LENGTH
C   TRPM      TURBINE RPM
C   CRPM      COMPRESSOR RPM
C   SPEED      MIN. RPM
C   STRE      REF. STRESS
C   RHO      MATERIAL DENSITY
C   R      HUB-TIP RATIO
C   ILCC      LOCATION INDICATOR
C   DO3      OUTER DIA. CUBED
C   DO      OUTER DIAMETER
C   DI      INNER DIAMETER
C   DOA      GUESS ON DO
C   DELD      DELTA ON DO
C   WT      WEIGHT

```

```

C   DN                               DN NUMBER OF BEARING
C
C
C*****
C
      SUBROUTINE SHAFT (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
      IR,TCL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C           *****
C           * COMMON BLOCKS *
C           *****
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTCL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KINDS(14,25),
      2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,I0
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,120) IWMEC(1,ICOMP),ICOMP,IOUTCD
C
C   DETERMINE TOTAL SHAFT POWER
C
      POWER=0.
      NT=3
10    NTURB=IWMEC(NT,ICOMP)
      POWER=DATOUT(1,NTURB)+POWER
      NT=NT+1
      IF (NT.EQ.6) GO TO 20
      IF (IWMEC(NT,ICOMP).NE.0.) GO TO 10
20    NCCM=IWMEC(7,ICOMP)
C
C   DETERMINE SHAFT LENGTH AND MIN. SPEED
C
      NTF=JCONF(NTURB,1)
      NCR=JCONF(NCOM,3)
      TLEN=TLENG(NTF)-TLENG(NCR)
      TRPM=RPMT(NTURB)
      CRPM=RPMT(NCOM)
      SPEED=AMIN1(TRPM,CRPM)
C
C   INPUT DESIGN DATA
C
      IF (DESVAL(1,ICOMP).EQ.0.) GO TO 30
      STRE=DESVAL(1,ICOMP)
      RHC=DESVAL(2,ICOMP)
      R=DESVAL(3,ICOMP)
      GO TO 40
30    STRE=DEFAULT(1,14)

```



```

      RHC=DEFAULT(2,14)
      R=DEFAULT(3,14)
40    IF (.NOT.ISII) GO TO 50
      STRE=STRE/CONVER(6)
      RHO=RHO/CONVER(5)
50    ILCC=IWMEC(2,ICOMP)
C
C    DETERMINE SHAFT LOCATION 1 IS INNER SHAFT
C
      IF (ILOC.NE.1) GO TO 60
      DO3=454048.43*POWER/(SPEED*STRE*(1.-R**4))
      DO=DO3**(.1./3.)
      DI=DO*R
      GO TO 90
C
C    CALCULATION FOR OUTER SHAFTS
C
      *****
C    NEWTON-RAPHSON INTERATION FOR SHAFT OUTER DIAMETER
C    *****
60    DI=DSHAF(ILOC-1)+.4
      DNEW=DI
      B=-DI**4
      A=-454048.*POWER/STRE/SPEED
      DO 70 I=1,50
      A1=DNEW**4+A*DNEW+B
      A2=4.*DNEW**3+A
      DOLD=DNEW
      DNEW=DOLD-A1/A2
      IF (ABS(DNEW-DOLD).LE..01) GO TO 80
      DNEW=AMAX1(DI,AMIN1(100.,DNEW))
70    CONTINUE
      WRITE (10,130) ICOMP
      DNEW=5.
80    DO=DNEW
90    DSHAF(ILOC)=DO
      DN=DO*SPEED*25.4/1000000.
      WT=.7853981*RHO*TLEN*(DO**2-DI**2)
      WATE(ICOMP)=WT
C
C    WRITE OUTPUT
C
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,140) ICOMP
      IF (ISIC) GO TO 100
      WRITE (10,150) DO,DI,TLEN,DN,WT
      IF (DN.GT.2.) WRITE (10,170) DN
      GO TO 110
100   DO=DO*CONVER(1)
      DI=DI*CONVER(1)
      TLEN=TLEN*CONVER(1)
      WT=WT*CONVER(3)
      WRITE (10,160) DO,DI,TLEN,DN,WT
110   CONTINUE
      RETURN
C

```

```

120  FORMAT (1H /14H *****/14H *           */4H * ,A4,I3,3H *
1/14H *           */13H *****,I1)
130  FORMAT (15H ERROR IN SHAFT,I4)
140  FORMAT (6H SHAFT,I4,/,34H   DO      DI   LENG      DN      WT)
150  FORMAT (5F7.2,/)
160  FORMAT (3F7.1,2F7.1,/)
170  FORMAT (15H THE DN VALUE OF,F4.2,15H MILLION IS HIGH)
      END

```

```

C*****
C
C SUBROUTINE(TURB)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE PERFORMS THE TURBINE PERFORMANCE
C CALCULATIONS AND THE BOOKKEEPING FOR THE
C MECHANICAL DESIGN.
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C EFFD
C TMECH
C DUCT
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C   ICOMP      ARG      COMPONENT NUMBER
C   IP      PRINT INDICATOR
C   NTT      COMPONENT NUMBER
C   NODEIS      BLEED MODE IN
C   NODEI      NODE IN
C   NODEO      NODE OUT
C   WI      AIRFLOW IN
C   TI      TEMPERATURE IN
C   PI      PRESSURE IN
C   ITURB      TURBINE INDICATOR
C   NT      TURBINE INDICATOR
C   FAI      FUEL AIR RATIO IN
C   EPI      EFFICIENCY
C   IDES      DATA INDICATOR
C   CFT      COOLING FLOW
C   TC      TEMPERATURE OF THE COOLING FLOW
C   CFF      COOLING FLOW TO THE FRONT OF TURBINE

```

C	CFR	COOLING FLOW TO THE BACK OF THE TURBINE
C	AT	MACH NUMBER
C	TLD	TURBINE LOADING PARAMETER
C	NRPM	RPM LOCATOR
C	RPM	RPM
C	RCC	CONTROL RADIUS
C	IDI	COMPRESSOR NUMBER FOR RCC
C	NODRCC	NODE FOR CONTROL RADIUS
C	CW	CORRECTED WEIGHT FLOW
C	HC	ENTHALPY OF COOLING GAS
C	HI	ENTHALPY OF INLET AIR
C	FAI	FUEL AIR RATIO
C	WI	AIRFLOW INTO THE COMPONENT
C	WHP	HORSE POWER
C	DHA	ACTUAL DELTA ENTHALPY
C	H3	ENTHALPY OUT
C	RP1	RELATIVE PRESSURE IN
C	DI1	IDEAL ENTHALPY
C	H2	IDEAL ENTHALPY OUT
C	T2	IDEAL TEMPERATURE OUT
C	RP2	RELATIVE PRESSURE OUT
C	PR	PRESSURE RATIO
C	PR1	PRESSURE RATIO
C	EF2T	EFFICIENCY
C	TR	TEMPERATURE RATIO
C	H4	EXIT ENTHALPY
C	FAO	FUEL AIR RATIO OUT
C	TO	TEMPERATURE OUT
C	PO	PRESSURE OUT
C	WO	AIRFLOW OUT
C	GA	GAMMA
C	GAC	GAS CONSTANT - R
C	VI	VELOCITY
C	VCR	CRITICAL VELOCITY
C	HST	STATIC ENTHALPY
C	TST	STATIC TEMPERATURE
C	PRST	STATIC RELATIVE PRESSURE
C	PST	STATIC PRESSURE
C	AT1	EXIT AREA
C	EFS	POLYTROPIC EFFICIENCY
C	ATD	MACH NUMBER IN OR EXIT AREA
C	XME	MACH NUMBER OUT
C	XMS	MACH NUMBER IN

C*****

C SUBROUTINE TURB (ICOMP)
 REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
 1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF

C *****
 C * COMMON BLOCKS *
 C *****

C COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(

```

140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTOL(20),PERPF(20)
COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
COMMON /CONVER/ CONVER(15)
COMMON /DEFAULT/ DEFAULT(15,20)
LOGICAL IWT,IPLT,IERR,ISII,ISIO

```

```

*****
* DATA STATEMENTS *
*****

```

```

DATA TSTD,PSTD,C1,FA,G,R/518.67,2116.22,778.,0.,32.174,53.34/
DATA LLPT/4HLPT /

```

```

C CHECK FOR BAD INLET TEMPERATURE. CALCULATE CORRECTED INLET FLOW
C (CW), COOLING FLOW ENTHALPY (HC) AND INLET ENTHALPY (H1)
C

```

```

IF (IOUTCD.GT.1) WRITE (10,70) IWMEC(1,ICOMP),ICOMP,IOUTCD
IP=IOUTCD
NTT=ICOMP
NODEIS=JCONF(NTT,2)
NODEI=JCONF(NTT,1)
NODEO=JCONF(NTT,3)
WI=WTF(NODEI)
TI=TCTEMP(NODEI)
PII=TGPRES(NODEI)
PI=PII*144.
ITURB=8
NT=5
IF (IWMEC(1,NTT).EQ.LLPT) ITURB=9
IF (IWMEC(1,NTT).EQ.LLPT) NT=7
FAI=FAR(NODEI)
EF1=DATCUT(8,NTT)
IDES=1
IF (DESVAL(1,NTT).EQ.0.) IDES=2
CFT=0.
TC=0.
IF (NODEIS.NE.0) TC=TCTEMP(NODEIS)
IF (NODEIS.NE.0) CFT=WTF(NODEIS)
CFF=CFT*DATING(2,NTT)*DATING(9,NTT)
CFR=CFT*DATING(2,NTT)*(1.-DATING(9,NTT))
GO TO (10,20),IDES
10 AT=DESVAL(1,NTT)
TLP=DESVAL(2,NTT)
GO TO 30
20 AT=DEFAULT(1,ITURB)
TLP=DEFAULT(2,ITURB)
30 NRPM=IWMEC(3,NTT)
RPM=RPMT(NRPM)
RPMT(NTT)=RPM

```

```

      IDI=IWMEC(4,NTT)
      IPOS=3
      IF (IDI.LT.0) IPOS=1
      NODRCC=NGDEI
      IDI=IABS(IDI)
      IF (IDI.NE.0) NODRCC=JCONF(IDI,IPOS)
      IF (IPOS.EQ.3) RCC=RO(2,NODRCC)/12.
      IF (IPOS.EQ.1) RCC=RO(1,NODRCC)/12.
      IF (DESVAL(10,NTT).NE.0.) RCC=DESVAL(10,NTT)/12.
      IF (DESVAL(10,NTT).NE.0..AND.ISII) RCC=RCC/CONVER(1)
      IF (TI.LT.200.) TI=200.
      IF (TI.GT.6000.) TI=6000.
      CW=WI*SQRT(TI/TSTD)/PI*PSTD
      HC=0.
      IF (NODEIS.NE.0) HC=STHERM(4,TC,FA)
      H1=STHERM(4,TI,FAI)
      H1=(H1*WI+HC*CFF)/(WI+CFF)
      FAI=FAI*WI/(WI+CFF)
      WI=WI+CFF
      TI=STHERM(1,H1,FAI)
C
C INITIALIZE EFFICIENCY (EF) AND CALCULATE ACTUAL WORK (WHP), ENTHALPY
C CHANGE ACROSS TURBINE (DHA), EXIT ENTHALPY (H3) AND EXIT PRESSURE
C RATIO (RP1)
C
      EF=ABS(EF1)
      WHP=DATCUT(1,NTT)
      DHA=WHP*.7068/WI
      IF (DHA.LE..0001) DHA=.0001
      H3=H1-DHA
      RP1=STHERM(2,TI,FAI)
C
C BEGIN EFFICIENCY ITERATION. CALCULATE IDEAL ENTHALPY (DHI) CHANGE
C ACROSS COMPONENT, IDEAL EXIT ENTHALPY (H2) AND TOTAL PRESSURE
C RATIO (RP2)
C
      K=0
40    K=K+1
      CHI=DHA/EF
      H2=H1-DHI
      T2=STHERM(1,H2,FAI)
      RP2=STHERM(2,T2,FAI)
C
C CALCULATE PRESSURE RATIO (PR) ACROSS COMPONENT AND EFFICIENCY (EF)
C
      PR=RP1/RP2
      PR1=-PR
      EF2T=EF
      CALL EFFD (TI,PR1,EF1,EF,FAI)
C
C CHECK FOR CONVERGENCE OF ITERATION
C
      IF (ABS((EF2T-EF)/EF).LE..0001) GO TO 50
      IF (K.GT.10) GO TO 50
      GO TO 40
50    IF (K.GT.10) WRITE (10,80) NT

```

```

C
C CALCULATE EXIT TOTAL TEMPERATURE (T3) AND TEMPERATURE RATIO (TR)
C
    T3=STHERM(1,H3,FAI)
    TR=TI/T3
C
C CALCULATE EXIT ENTHALPY (H4), FUEL-TO-AIR RATIO (FAO) AND TOTAL
C TEMPERATURE (T4) AFTER ADDITION OF COOLING FLOW
C
    H4=(H3*WI+HC*CFR)/(WI+CFR)
    FAC=FAR(NCDEO)
    TO=STHERM(1,H4,FAO)
C
C CALCULATE INLET AREA (AT - DESIGN) OR MACH NUMBER (XM - OFF-DESIGN),
C AND ACTUAL PRESSURE LOSS (DP2) AND INLET DUCT EXIT TOTAL PRESSURE
C (PO1)
    CALL DUCT (TI,PI,WI,AT,FAI,XM,PS,DQ,ISIO,IP)
C
C CALCULATE EXIT TOTAL PRESSURE (PO), FLOW (WO), VELOCITY (V1) AND
C INLET CRITICAL SONIC VELOCITY (VCR)
C
    PO=PI/PR
    WO=WI+CFR
    GA=STHERM(5,TI,FAI)
    GAC=STHERM(6,FAI,FAI)
    V1=SQRT(2.*G*C1*DHA)
    VCR=SQRT((G*GA*GAC*TI)/((1.+GA)/2.))
    IF (V1.LT.VCR) VCR=V1
C
C CALCULATE STATIC ENTHALPY (HST), TEMPERATURE (TST), PRESSURE (PST)
C AND EXIT NOZZLE AREA (AT1)
C
    HST=H1-VCR/2.*VCR/G/C1
    TST=STHERM(1,HST,FAI)
    RPST=STHERM(2,TST,FAI)
    PST=PI/RP1*RPST
    AT1=WI/PST*R/VCR*TST
C
C CALCULATE COMPONENT MECHANICAL DESIGN AND DIMENSIONS
C
    EFS=EF1
    XMS=XM
    CALL TMECH (IP,IDES,NT,H1,DHA,DHI,RPM,WI,TI,PI,FAI,RCC,WHP,TLP,ITU
1RB,EFS,XMS,XME,AT,FACL,WT,TL,NTT)
    ATC=XME
C
C CALCULATE TURBINE EXIT AREA (ATD - DESIGN) OR MACH NUMBER (XME -
C OFF-DESIGN), DYNAMIC PRESSURE (QTEX), REYNOLDS NUMBER (RENTX)
C AND PRESSURE LOSS (DP2)
C
    CALL DUCT (TO,PO,WO,ATD,FAO,XME,PS,QTEX,ISIO,IP)
C
C WRITE TURBINE PERFORMANCE DATA
C
    IF (IP.NE.2) RETURN
    IF (ISIO) GO TO 60

```

```

WRITE (10,90)
WRITE (10,100) PR,TR,EF,PO,T3,TO
WRITE (10,110)
WRITE (10,120) H1,H3,AT1,WI,WHP
WRITE (10,130) WATE(ICOMP)
RETURN
60  WRITE (10,90)
    SPO=PO*CONVER(11)
    ST3=T3*CONVER(8)
    STO=TO*CONVER(8)
    SH1=H1*CONVER(9)
    SH3=H3*CONVER(9)
    SAT1=AT1*CONVER(4)
    SWI=WI*CONVER(3)
    SWHP=WHP*CONVER(10)
    WT1=WATE(ICOMP)*CONVER(3)
    WRITE (10,100) PR,TR,EF,SPO,ST3,STO
    WRITE (10,110)
    WRITE (10,120) SH1,SH3,SAT1,SWI,SWHP
    WRITE (10,130) WT1
    RETURN
C
70  FORMAT (1H /14H *****/14H *           */4H * ,A4,I3,3H *
1/14H *           */13H *****,I1)
80  FORMAT (8H TURBINE,I3,37H EFFICIENCY ITERATIONS EXCEED MAXIMUM)
90  FORMAT (46H  PR      TR      AD EF      PO      TO      TO.1)
100  FORMAT (3F8.4,3F8.1)
110  FORMAT (37H  H IN      H OUT      AREA      FLOW      HP)
120  FORMAT (4F8.2,F8.0,F8.4,/)
130  FORMAT (/ ,41H *****/ TOTAL TURB WEIGHT IS,F10.3,/)
END

```


C*****

C
C SUBROUTINE(TMECH)
C -----

C
C PURPOSE
C -----

C THIS ROUTINE PERFORMS THE TURBINE MECHANICAL
C DESIGN.

C
C
C CALLING RCUTINES
C -----

C
C
C REQUIRED SUBROUTINES
C -----

C STRESS
C DUCT1
C EFFD
C TURWT
C MODIFICATION HISTORY
C -----

C
C
C DATE ID ANALYST DISCRIPTION
C -----

C
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C E. ONAT , R. J. PERA/FORTAN IV/ 09 30 76

C
C
C
C GLOSSARY
C -----

C
C
C NAME ORIGIN USAGE DISCRIPTION
C -----

C IP	ARG		PRINT INDICATOR
C IDES	ARG		DATA LOCATION INDICATOR
C NT	ARG		TURBINE TYPE INDICATOR
C H1	ARG		ENTHALPY
C CHA	ARG		DELTA ENTHALPY
C DHI	ARG		IDEAL DELAT ENTHALPY
C RPM	ARG		RPM
C WI	ARG		AIRFLOW IN
C TI	ARG		TEMPERATURE IN
C PI	ARG		PRESSURE IN
C FA	ARG		F/A RATIO IN
C RC	ARG		CONTROL RADIUS FOR TURBINE
C NS			NUMBER OF STAGES
C HT			HUB-TIP RATIO
C ST			STRESS
C WHP	ARG		HORSEPOWER
C RT			TIP RADIUS

C	TLP	ARG	TURBINE LOADING PARAMETER
C	ITURB	ARG	TURBINE INDICATOR
C	PEF	ARG	POLYTROPIC EFFICIENCY
C	XM		MACH IN
C	XME		MACH OUT
C	AIN	ARG	AREA IN
C	NTT	ARG	COMPONENT NUMBER
C	GR		GEAR RATIO
C	GBWT		GEAR BOX WEIGHT
C	OM		OMEGA
C	UTM		MAX. TIP SPEED
C	UT		TIP SPEED
C	RH		HUB RADIUS
C	A		AREA IN
C	DIAM		TIP DIAMETER
C	TR		BLADE TAPER RATIO
C	TORQ		TORQUE
C	NODEI		NODE IN
C	NGDEO		NODE OUT
C	RTIN		TIP RADIUS - IN
C	RHIN		HUB RADIUS - IN
C	SOLC		SOLIDITY
C	ARIC		TURBINE ASPECT RATIO IN
C	ARCC		TURBINE ASPECT RATIO OUT
C	CIMN		MACH INTO TURBINE
C	CCMN		MACH OUT OF TURBINE
C	STR		REF. STRESS FOR DISK
C	COCK		COOLING FLOW
C	MODE		DESIGN MODE FOR TURBINE
C	RPMR		RPM RATIO - NMAX/NDES
C	DELMs		MACH IN - MACH OUT
C	DELAR		ASPECT RATIO IN - ASPECT RATIO OUT
C	WT		STAGE WEIGHT
C	TL		STAGE LENGTH
C	PCS		PRESSURE IN OR OUT
C	EF		EFFICIENCY
C	TTOS		TEMPERATURE IN OR OUT
C	HCS		ENTHALPY IN OR OUT
C	XMCS		MACH INTO STAGE
C	AR		ASPECT RATIO OF STAGE
C	RTB		TIP RADIUS OF BLADE
C	RM		MEAN RADIUS OF BLADE
C	RHB		HUB RADIUS OF BLADE
C	RHBA		HUB RADIUS - IN.
C	GAG		GAMMA
C	HIS		ENTHALPY INTO STAGE
C	TTIS		TEMPERATURE INTO STAGE
C	PIS		PRESSURE INTO STAGE
C	CW		CORRECTED AIRFLOW
C	RTBA		TIP RADIUS - IN.
C	UTP1		TIP SPEED OF BLADE
C	BF		BLADE HEIGHT
C	WTFRA		FRAME WEIGHT
C			
C			
C	*****		

```

C      SUBROUTINE TMECH (IP,IDES,NT,H1,DHA,DHI,RPM,WI,PI,FA,RC,WHP,TLPI,ITURB,PEF,
C      XM,XME,AIN,FACL,WT,TL,NTT)
C      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERROR,
C      TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
C      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
C      2T,DEPV(20),DTOL(20),PERPF(20)
C      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
C      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C      2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C      3JCVIND(20),JCVDEP(20),KDTP(20),IDONE(60)
C      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C      10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
C      2UTCD,NSTAG(60)
C      COMMON /CONVER/ CONVER(15)
C      COMMON /DEFAULT/ DEFAULT(15,20)
C      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C      *****
C      * DATA STATEMENTS *
C      *****
C
C      DATA TSTD,PSTD,PIE,CC1,G/518.67,2116.22,3.14159,778.,32.174/
C      DIMENSION PRR(10),GR(3),GBWT(3)
C
C      CHECK FOR BAD INPUTS AND CASE TYPE.  SET FLAG FOR STAGE-BY-STAGE
C      TURBINE DESIGN
C
C      IF (RPM.EQ.0.) RETURN
C
C      INITIALIZE TURBINE DESIGN VALUES
C
C      SN=0.
C      NNT=NT-4
C      RPM2=RPM
C
C      FOR DESIGN CASE: INITIALIZE STAGE DESIGN VALUES
C
C      OM=RPM*2.*PIE/60.
C      KK=0
C      UTM=RC*OM
C
C      BEGIN ITERATION FOR NUMBER OF STAGES (SN) BASED ON BLADE
C      TIP SPEED (UT)
C
C      IF (IWMEC(5,NTT).NE.0) SN=IWMEC(5,NTT)
C      IF (IWMEC(5,NTT).NE.0) GO TO 20
10    SN=SN+1.
C      KK=KK+1
C      IF (SN.GT.40.) GO TO 40

```

```

20    DH1=DHA/SN
      UT=SQRT(TLP*DH1*G*2.*CC1)
C
C CHECK FOR CONVERGENCE AND CALCULATE BLADE TIP RADIUS (RT)
C
      IF (IWMEC(5,NTT).NE.0) GO TO 30
      IF (UT.GT.UTM) GO TO 10
30    RT=UT/OM
      GO TO 50
C
C ERROR IN NUMBER OF STAGES
C
40    IF (ISIO) SRC=PC*CONVER(1)
      IF (ISIC) WRITE (10,200) NT,SRC
      IF (.NOT.ISIO) WRITE (10,200) NT,RC
      RETURN
C
C FOR DESIGN CASE: CALCULATE HUB RADIUS (RH), BLADE TIP RADIUS (RT)
C AND CHECK FOR CONVERGENCE ON NUMBER OF STAGES
C
50    A=AIN
      C1=RT*RT-A/PIE
      IF (C1.LE.0.) C1=.0001
      RH=SQRT(C1)
      RT=SQRT(A/PIE+RH*RH)
C
C CALCULATE BLADE TIP DIAMETER (DIAM) IN INCHES, HUB-TO-TIP RATIO (HT),
C TIP SPEED (UT) AND NUMBER OF STAGES (NS)
C
      DIAM=RT*24.
      HT=RH/RT
      UT=RT*2.*PIE/60.*RPM2
      NS=FIX(SN+.01)
      SND=SN
C
C INITIALIZE BLADE TAPER RATIO (TR). CALCULATE SHAFT TORQUE (TORQ)
C AND 1ST BLADE STRESS (ST)
C
      TR=1.
      TORQ=WHP/RPM2*63025.
      RHO=0.
      IF (DESVAL(11,NTT).NE.0.) RHO=DESVAL(11,NTT)
      IF (ISII.AND.DESVAL(11,NTT).NE.0.) RHC=RHO/CONVER(5)
      RHO1=RHO,
      TM=0.
      CALL STRESS (RT,TI,UT,HT,RPM2,ST,TR,NT,IP,RHO1,TM)
      RTIN=RT*12.
      RHIN=RH*12.
      IF (IP.NE.2) GO TO 70
C
C WRITE TURBINE DESIGN VALUES
C
      WRITE (10,210) NTT
      WRITE (10,220)
      IF (ISIO) GO TO 60
      WRITE (10,230) HT,SN,TLP,A

```

```

WRITE (10,240)
WRITE (10,250) UT,RTIN,RHIN,DHA,RPM2,TORQ
GO TO 70
60  SA=A*CONVER(4)
    WRITE (10,230) HT,SN,TLP,SA
    SRT=RTIN*CONVER(1)
    SRT=RHIN*CONVER(1)
    SUT=UT*CONVER(2)
    SDHA=DHA*CONVER(9)
    STORQ=TORQ*CONVER(2)*CONVER(3)
    WRITE (10,240)
    WRITE (10,250) SUT,SRT,SDHA,RPM2,STORQ
C
C THIS IS THE STAGE-BY-STAGE TURBINE DESIGN SECTION ENCOUNTERED ONLY
C FOR A DESIGN CASE OR A COPY OF A DESIGN CASE
C
C INITIALIZE THE APPROPRIATE DESIGN VALUES
C
70  NODEI=JCONF(NTT,1)
    NODEO=JCONF(NTT,3)
    RI(1,NODEI)=RHIN
    RO(1,NODEI)=RTIN
    GO TO (80,90),IDES
80  SOLC=DESVAL(3,NTT)
    ARIC=DESVAL(4,NTT)
    AROC=DESVAL(5,NTT)
    CIMN=XM
    COMN=DESVAL(6,NTT)
    STR=DESVAL(7,NTT)
    COOK=DATINP(2,NTT)
    MODE=IFIX(DESVAL(8,NTT)+.01)
    RPMR=DESVAL(9,NTT)
    GO TO 100
90  SOLC=DEFAULT(3,ITURB)
    ARIC=DEFAULT(4,ITURB)
    AROC=DEFAULT(5,ITURB)
    CIMN=XM
    COMN=DEFAULT(6,ITURB)
    STR=DEFAULT(7,ITURB)
    COOK=DATINP(2,NTT)
    MODE=IFIX(DEFAULT(8,ITURB)+.01)
    RPMR=DEFAULT(9,ITURB)
100 IF (.NOT.ISII) GO TO 110
    STR=STR/CONVER(6)
C
C CALCULATE DELTA MACH NUMBER (DELMNS), ASPECT RATIO (DELAR) AND
C ENTHALPY (DHAS) PER STAGE AND INITIALIZE VALUES FOR STAGE-BY-STAGE
C CONSTANT HUB TURBINE DESIGN
C
110 DELMNS=(CIMN-COMN)
    IF (DELMNS.NE.0.) DELMNS=DELMNS/SN
    IF (COMN.EQ.0.) DELMNS=0.05
    DELAR=ARIC-AROC
    IF (SN.GT.1.) DELAR=DELAR/(SN-1.)
    IF (AROC.EQ.0..AND.NT.EQ.5) DELAR=0.05
    IF (AROC.EQ.0..AND.NT.GT.5) DELAR=0.2

```

```

      DHAS=DHA/SN
      WT=0.
      TL=0.
      POS=PI
      EF=-PEF
      TTOS=TI
      HOS=HI
      XMCS=CIMN+DELMNS
      AR=ARIC+DELAR
      XME=CCMN
      IF (XME.EQ.0.) XME=CIMN-(DELMNS*SN)
C
C CALCULATE CONSTANT HUB RADIUS (RHB) - IN INCHES (RHBA) AND 1ST
C STAGE INLET GAMMA (GAO)
C
      RTB=RT
      RM=RT*RT-AIN/(2.*PIE)
      IF (RM.LT.0.) GO TO 190
      RM=SQRT(RM)
      CHECKA=RT*PT-AIN/PIE
      IF (CHECKA.LE.0.) GO TO 190
      RHB=SQRT(CHECKA)
      RHBA=RHB*12.
      GAO=STHERM(5,TI,FA)
      NSTAG(NTT)=NS
      NST=NS+1
C
C BEGIN STAGE-BY-STAGE TURBINE DESIGN
C
      DO 160 I=1,NST
C
C INITIALIZE STAGE INLET VALUES
C
      XMCS=XMCS-DELMNS
      IF (XMCS.LE.0.) GO TO 190
      HIS=HOS
      TTIS=TTOS
      PIS=POS
      AR=AR-DELAR
C
C CALCULATE STAGE EXIT ENTHALPY (HOS), TOTAL TEMPERATURE (TTOS), INLET
C GAMMA (GAI), EXIT GAMMA (GAO), AVERAGE GAMMA (GAV) AND TOTAL PRESSURE
C RATIC (PRR) ACROSS THE STAGE
C
      HOS=HIS-DHAS
      TTCS=STHERM(1,HOS,FA)
      GAI=GAO
      GAO=STHERM(5,TTOS,FA)
      GAV=(GAI+GAO)/2.
      TOS1=ALOG(TTIS/TTOS)/EF
      TOS2=EXP(TOS1)
      PFR(I)=TOS2**((GAV/(GAV-1.)))
C
C CALCULATE STAGE EXIT TOTAL PRESSURE (POS), INLET CORRECTED FLOW (CW)
C AND INLET AREA (A1)
C

```

```

      POS=PIS/PRR(I)
      A1=0.
      CALL DUCT1 (TTIS,PIS,WI,GAI,XMCS,A1)
      GO TO (120,130,140),MODE
C
C   CALCULATES RHB FOR CONSTANT TIP RAD
C
120   RHB=RTB*RTB-A1/PIE
      IF (RHB.LE.0.) GO TO 190
      RHB=SQRT(RHB)
      GO TO 140
C
C   CALCULATES RHB FOR CONSTANT MEAN
C
130   RHB=RM*RM-A1/(2.*PIE)
      IF (RHB.LE.0.) GO TO 190
      RHB=SQRT(RHB)
      GO TO 140
C
C   CALCULATE BLADE TIP RADIUS (RTB), BLADE HEIGHT (BH), NUMBER OF
C   BLADES (NB) AND HUB-TO-TIP RATIO (HTB)
C
140   RTB=SQRT(A1/PIE+RHB*RHB)
      BH=RTB-RHB
      NB=FIX(PIE*2.*RTB*SOLC*AR/BH)
      HTB=RHB/RTB
C
C   CALCULATE BLADE TIP RADIUS (RTBA) IN INCHES, TIP SPEED (UTP1)
C   AND STRESS LEVEL (ST1)
C
      RTBA=RTB*12.
      RHBA=RHB*12.
      UTP1=RPM2*2.*PIE/60.*RTB
      IF (I.GE.NST) GO TO 160
      UTP1=UTP1*RPMR
      IPP=0
      CALL STRESS (RTB,TTIS,UTP1,HTB,RPM2,ST1,TR,NT,IPP,RHO1,TM)
C
C   CALCULATE STAGE WEIGHT (WTT) AND LENGTH (TLT) AND TOTAL COMPONENT
C   WEIGHT (WT) AND LENGTH (TL)
C
      BH=BH*12.
      IF (IP.EQ.2) WRITE (10,310) I
      CALL TURWT (RHBA,BH,ST1,NB,AR,STR,COOK,RHO1,WTT,TLT)
      WT=WT+WTT
      TL=TL+TLT
      IF (IP.NE.2) GO TO 160
      WRITE (10,280)
      IF (ISIG) GO TO 150
      WRITE (10,290) PRR(I),DHAS,XMCS,A1,RHBA,RTBA,NB,UTP1,ST1,WTT,TLT
      GO TO 160
150   SDHAS=DHAS*CONVER(9)
      SA1=A1*CONVER(4)
      SRHBA=RHBA*CONVER(1)
      SRTBA=RTBA*CONVER(1)
      SUTP1=UTP1*CONVER(2)

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      SST1=ST1*CONVER(6)
      SWTT=WTT*CONVER(3)
      STLT=TLT*CONVER(1)
      WRITE (10,300) PRR(I),SDHAS,XMCS,SA1,SRHBA,SRTBA,NB,SUTP1,SST1,SW
160  IT,STLT
      CONTINUE
      WTFRA=0.
      IF (IWMEC(2,NTT).NE.0.) CALL FRAME (RTBA,3,WTFRA,IP)
      IF (IWMEC(2,NTT).NE.0) TL=TL+TL/NS
      WT=WT+WTFRA
      RI(2,NODE0)=RHBA
      RO(2,NODE0)=RTBA
      ALENG(NTT)=TL
      WATE(NTT)=WT
      IF (IP.NE.2) RETURN
C
C WRITE COMPONENT DIMENSICNS
C
      WRITE (10,260)
      IF (ISIG) GO TO 170
      WRITE (10,270) NS,TL,WT
      GO TO 180
170  TL=TL*CONVER(1)
      WT=WT*CONVER(3)
      WRITE (10,270) NS,TL,WT
180  RETURN
190  WRITE (10,320) NTT
      RETURN
C
200  FORMAT (8H TURBINE,I3,31H WORK OR RADIUS TOO HIGH, RC =,F6.2)
210  FORMAT (9H TURBINE,I3,20H MECHANICAL DESIGN )
220  FORMAT (36H H/T N STG LOADING AREA )
230  FORMAT (4F8.3)
240  FORMAT (49H UT RTIP RHUB DEL H RPM TORQ )
250  FORMAT (5F8.1,F8.0)
260  FORMAT (/,26H N STG LENGTH WEIGHT )
270  FORMAT (I6,F9.2,F8.2,/)
280  FORMAT (42H PR DEL H MACH AREA R HUB R TIP NB, 30H U TIP
1  STR WEIGHT LENGTH)
290  FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F8.2)
300  FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F8.2)
310  FORMAT (/,7H STAGE ,I4)
320  FORMAT (8H TURBINE,I3,40H STAGE AND BLADE PARAMETERS MEANINGLESS)
      END

```



```

C SUBROUTINE(TURWT)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGHT
C OF TURBINE STAGES.
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C      RHBA      ARG      HUB RADIUS - IN
C      BH      ARG      BLADE HEIGHT - IN
C      ST1      ARG      STRESS
C      NB      ARG      NUMBER OF BLADES
C      AR      ARG      ASPECT RATIO
C      STR      ARG      REFERENCE STRESS
C      R+CB      ARG      BLADE DENSITY
C      COOK      COOLING FLOW
C      WT      WEIGHT - LBF
C      TL      LENGHT - IN
C      STF      STRESS FACTOR
C      DISKV      DISK VOLUME -LBF/CU IN
C      BLADEW      BLADE WEIGHT - LBF
C      BLADEL      BLADE LENGTH - IN
C      WNGZZ      VANE WEIGHT - LBF
C      TLNOZ      VANE LENGHT - IN
C      WTNB      NUTS AND BOLTS WEIGHT - LBF
C      CASEW      CASE WEIGHT - LBF
C

```

```

C
C*****
C
C      SUBROUTINE TURWT (RHBA,BH,ST1,NB,AR,STR,COOK,RHOB,WT,TL)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
      1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KINDS(14,25),
      2NCCMP,NGSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      TR=1.
C
C READ IN VALUES OF REFERENCE STRESS AND COOLING
C
      COOL=.8
      IF (COOK.LE.0.) COOL=1.
C
C CALCULATE DISK VOLUMES
C
      STF=ST1*RHBA/STR/12.
      DISKV=.95238*STF
      IF (STF.GT..168) DISKV=1273.20662*STF**4-1188.71514*STF**3+432.626
      1981*STF**2-67.4673543*STF+3.90623508
      IF (STF.GT..3) DISKV=7.18751*STF-1.33625
C
C CALCULATE DISK WEIGHT
C
      DISKW=DISKV*.296*(2.*RHBA)**2
C
C CALCULATE BLADE WEIGHT AND LENGTH
C
      BLADEW=.195*BH**3/AR**2*RHOB*NB*COOL
      BLADEL=BH/AR
C
C CALCULATE NOZZLE WEIGHT AND LENGTH
C
      WNOZZ=.144*BH**3/(AR/2. )**2*RHOB*(NB)
      TLNOZ=BH/AR*2.
      TL=(TLNOZ+BLADEL)*1.17
C
C CALCULATE NUTS AND BOLTS WEIGHT

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```

C      WTNB=RHBA*.75*2.*3.1416*.075*TL*.296*RHBA
C
C CALCULATE CASEWEIGHT
C      CASEW=(RHBA+BH)*2.*3.1416*.1*.286*TL
C
C CALCULATE TOTAL STAGE WEIGHT AND LENGTH
C
      WT=DISKW+BLADEW+WNOZZ+WTNB+CASEW
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,30)
      IF (ISIC) GO TO 10
      WRITE (10,20) DISKW,BLADEW,WNOZZ,WTNB,CASEW,AR
      RETURN
10     DISKW=DISKW*CONVER(3)
      BLADEW=BLADEW*CONVER(3)
      WNOZZ=WNOZZ*CONVER(3)
      WTNB=WTNB*CONVER(3)
      CASEW=CASEW*CONVER(3)
      WRITE (10,40) DISKW,BLADEW,WNOZZ,WTNB,CASEW,AR
      RETURN
C
20     FORMAT (5F7.1,F6.2)
30     FORMAT (39H  DISK   BLADE   VANE   HWD   CASE   AR)
40     FORMAT (5F7.2,F6.2)
      END

```

```

C*****
C
C SUBROUTINE(WMIXR)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE CALCULATES THE WEIGHT AND DIMENSION
C OF FORCED MIXERS
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C      E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C      ICOMP      ARG      COMPONENT NUMBER
C      NCDEII      NODE IN OF INNER
C      NODEOO      NODE IN OR OUTER
C      AII      AREA OF INNER
C      AIO      AREA OF OUTER
C      RII      REF. RADIUS OF INNER
C      RIO      REF. RADIUS OF OUTER
C      RMI2      MEAN RADIUS OF INNER SQUARED
C      RI2      INNER RADIUS OF MIXER SQUARED
C      RMI      INNER RADIUS OF MIXER
C      RMC      MID RADIUS OF MIXER
C      ROO      OUTER RADIUS OF MIXER
C      SPL      SPECIFIC LENGTH SQRT(L/4A/PIE)
C      PN      NUMBER OF PASSAGES
C      ALE      MIXER LENGTH
C      WTM      MIXER WEIGHT
C
C*****

```

```

C      SUBROUTINE WMIXR (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERROR,
      TCL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C      *****
C      * COMMON BLOCKS *
C      *****
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
      2NCCMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C      *****
C      * DATA STATEMENTS *
C      *****
C
      DATA LFMIX/4HFMIX/
C
C      INPUT DESIGN VALUES
C
      INOD=1
      IF (IWMEC(2,ICOMP).NE.0) INOD=2
      NODEO=JCONF(ICOMP,3)
      GO TO (10,20),INOD
10     NODEII=JCONF(ICOMP,1)
      NODEIC=JCONF(ICOMP,2)
      AII=DATCUT(1,ICOMP)
      AIO=DATOUT(2,ICOMP)
      GO TO 30
20     NODEII=IWMEC(2,ICOMP)
      NODE=JCONF(ICOMP,1)
      NODEIC=JCONF(ICOMP,2)
      AII=DATOUT(1,ICOMP)
      AIO=DATCUT(2,ICOMP)
      IF (NODEII.EQ.NODE) GO TO 30
      AII=DATCUT(2,ICOMP)
      AIO=DATOUT(1,ICOMP)
      NODEIO=NODE
30     IDES=1
      IF (IWMEC(1,ICOMP).EQ.LFMIX) IDES=2
C
C      CALCULATE DIMENSIONS OF MIXER
C
      RII=RI(2,NODEII)
      ROI=RO(2,NODEII)

```

```

RMI2=(ROI**2+RII**2)/2.
RI2=RMI2-AII/6.2832
IF (RI2.LE.0.) RI2=0.
RMI=SQRT(RI2)
RMO=SQRT(AII/3.1416+RI2)
ROO=SQRT(AIO/3.1416+RMO**2)
RI(1,NODEII)=RMI
RO(1,NODEII)=RMO
RI(1,NODEIO)=RMO
RO(1,NODEIO)=ROO
RI(2,NODEO)=RMI
RO(2,NODEO)=ROO
IF (IDES.EQ.2) GO TO 40
ALENG(ICOMP)=0.
WATE(ICOMP)=0.
RETURN

```

```

C
C  DESIGN FOR FORCED MIXER
C

```

```

40  AA=(AII+AIO)/2.
    ITP=1
    IF (DESVAL(1,ICOMP).EQ.0.) ITP=2
    GO TO (50,60),ITP
50  SPL=DESVAL(1,ICOMP)
    PN=DESVAL(2,ICOMP)
    GO TO 70
60  SPL=DEFAUL(1,16)
    PN=DEFAUL(2,16)

```

```

C
C  CALCULATE WEIGHT AND LENGTH
C

```

```

70  ALE=SPL*SQRT(4.*AA/3.1416)
    WTM=(3.927*RMO+1.25*PN*(ROO-RMI))*ALE*.028
    WATE(ICOMP)=WTM
    ALENG(ICOMP)=ALE
    IF (IOUTCD.NE.2) RETURN
    WRITE (10,90) IWMEC(1,ICOMP),ICOMP,IOUTCD
    IF (ISIO) GO TO 80
    WRITE (10,100) ALE,WTM
    RETURN
80  WTM=WTM*CONVER(3)
    ALE=ALE*CONVER(1)
    WRITE (10,100) ALE,WTM
    RETURN

```

```

C
90  FORMAT (1H /14H *****/14H *                */4H * ,A4,I3,3H *
1/14H *                */13H *****,I1)
100 FORMAT (8H LENGTH=,F7.2,9H WEIGHT =,F8.2,/)
    END

```

[illegible]

C _____

C

C

C _____

C -----

C _____

C

C

C	ICOM	ARG	COMPONENT NUMBER
C	NCDEOP		NODE OUT PRIMARY
C	NODEOS		NODE OUT SECONDARY
C	NODEI		NODE IN
C	BYP		BYPASS RATIO
C	RSO		OUTER RADIUS
C	RSI		INNER RADIUS
C	RM		SPLITTER RADIUS

C

C
C
C
C

B-68

C

```

COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTOL(20),PERPF(20)
COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD
COMMON /CONVER/ CONVER(15)
COMMON /DEFAULT/ DEFAULT(15,20)
LOGICAL IWT,IPLT,IERR,ISII,ISIO

```

C

C

ESTABLISH INPUT VALUES AND DETERMINE DIMENSIONS

C

```

NODEOP=JCONF(ICOMP,3)
NODEOS=JCONF(ICOMP,4)
NODEI=JCONF(ICOMP,1)
BYP=DATOUT(1,ICOMP)
RSC=RO(2,NODEI)
RSI=RI(2,NODEI)
IF (DESVAL(1,ICOMP).EQ.0.) GO TO 10
WI=WTF(NODEI)
TI=TOTEMP(NODEI)
PI=TOPRES(NODEI)
AI=DESVAL(1,ICOMP)
HTR=DESVAL(2,ICOMP)
IP=0
CALL DUCT (TI,PI,WI,AI,XM,PS,Q,ISIO,IP)
RSO=SQRT(AI*144./3.14159/(1.-HTR**2))
RSI=RSC*HTR
RO(2,NODEI)=RSC
RI(2,NODEI)=RSI
10 RM=SQRT((RSO**2+BYP*RSI**2)/(1.+BYP))
RI(2,NODEOP)=RSI
RO(2,NODEOP)=RM
RI(2,NODEOS)=RM
RC(2,NODEOS)=RSO
WATE(ICOMP)=0.
ALENG(ICOMP)=0.
RETURN
END

```


C*****

C
C SUBROUTINE(WTNOZ)

C -----
C
C PURPOSE
C -----

C THIS ROUTINE CALCULATES DIMENSIONS AND WEIGHT
C OF CONVERGENT AND DIVERGENT NOZZLES.

C
C REQUIRED SUBROUTINES
C -----

C
C MODIFICATION HISTORY
C -----

C DATE ID ANALYST DISCRIPTION
C -----

C
C AUTHOR/LANGUAGE/DATE
C -----

C E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76

C
C GLOSSARY
C -----

NAME	ORIGIN	USAGE	DISCRIPTION
-----	-----	-----	-----
ICOM	ARG		COMPONENT NUMBER
NCDEI			NODE IN
NCDEO			NODE OUT
TI			TEMPERATURE IN - DEG R
RHC			MATERIAL WEIGHT PER SQIN
ITYP			NOZZLE TYPE
NCR			REFERENCE NODE FOR OUTER RADIUS
RNO			OUTER RADIUS - IN
IDES			DESIGN VALUE INDICATOR
TLD			LENGHT/DIAMETER
WTN			WEIGHT - LBF
ALN			LENGHT - IN
TYP			TYPE NOZZLE SCALER

C*****

C
C SUBROUTINE WTNOZ (ICOMP)
C REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C 1R,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF

C
C *****
C * COMMON BLOCKS *
C *****

```

C      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,110) IWMEC(1,ICOMP),ICOMP,IOUTCD

```

```

C
C      ESTABLISH INPUT VALUES
C

```

```

      NODEI=JCONF(ICOMP,1)
      NODEO=JCONF(ICOMP,3)
      TI=TOTEMP(NODEI)
      RHO=.0168
      IF (TI.GT.1160.) RHO=.0283
      ITYP=IWMEC(2,ICOMP)
      NCR=NODEI
      RNO=RO(2,NCR)
      JTYP=1
      IF (IWMEC(3,ICOMP).GT.0) JTYP=2
      IF (IWMEC(3,ICOMP).LT.0) JTYP=3
      GO TO (30,20,10),JTYP
10     NC=-IWMEC(3,ICOMP)
      NCR=JCONF(NC,1)
      RNO=RC(1,NCR)
      GO TO 30
20     NC=IWMEC(3,ICOMP)
      NCR=JCONF(NC,3)
      RNO=RO(2,NCR)
30     IDES=1
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (40,50),IDES
40     TLD=DESVAL(1,ICOMP)
      GO TO 60
50     TLD=DEFAULT(1,18)
60     RO(1,NODEI)=RNO
      RO(2,NODEO)=RNO-2.

```

```

C
C      CALCULATE WEIGHT AND LENGTH FOR CONVERGENT NOZZ
C

```

```

      WTN=4.*3.1416*RHO*TLD*RNO**2
      ALN=2.*RNO*TLD
      TYP=1.
      IF (ITYP.NE.1) TYP=2.75

```

```

C
C      CALCULATE WEIGHT FOR VARIABLE NOZZLE
C

```

```

      WTN=WTN*TYP

```

```

      WTNT=WTN
C    CALCULATE THRUST REVERSER WT
      WTTR=0.
      IF (IWMEC(4,ICOMP).EQ.0) GO TO 90
      PO=TOPRES(NODEI)
      WC=CCRFLC(NODEI)/1.54972555
      PRN=PO/14.696
      CMIX=1.
      IF (IWMEC(4,ICOMP).EQ.1) GO TO 70
      B1=.23014*PRN+.56091
      WTTR=(2.2222*WC+11.1)*B1*CMIX
      GO TO 80
70    A1=1.0036*PRN-.5054
      IF (A1.LE.1.) A1=1.
      WTTR=(.52631*WC+423.)*A1
80    WTNT=WTN+WTTR
90    WATE(ICOMP)=WTNT
      ALENG(ICOMP)=ALN
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,120) ICOMP
      IF (ISIC) GO TO 100
      WRITE (10,130) WTN,ALN,WTTR
      RETURN
100   WTN=WTN*CONVER(3)
      ALN=ALN*CONVER(1)
      WTTR=WTTR*CONVER(3)
      WRITE (10,130) WTN,ALN,WTTR
      RETURN
C
110   FORMAT (1H /14H *****/14H *           */4H * ,A4,I3,3H *
1/14H *           */13H *****,I1)
120   FORMAT (8H NOZZLE ,I4)
130   FORMAT (9H WEIGHT= ,F8.2,9H LENGTH= ,F8.3,7H TR WT=,F8.2,/)
      END

```

```

BLOCK DATA
COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
COMMON /CONVER/ CONVER(15)
DATA DESVAL/900*0./
COMMON /DEFAULT/ DEFAULT(15,20)
DATA IWMEC/420*0/
DATA CONVER/2.540,.3048,.4536,.0929,.027681,.68948,4.882,.55556,1.
105435,.07457,47.88,4*0./
DATA DEFAULT/.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,
11.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3
2.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0
3.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.5
4,1.5,.4,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.4,1.4,.7,1.5,3.,1.5
5,.3,0.,0.,1.,0.,2.,1.,0.,0.,.3,.25,1.5,1.5,1.5,.45,125000.,2.,1.,6
6*0.,.45,.25,1.5,2.,4.,.55,125000.,2.,1.,6*0.,100.,.015,13*0.,150.,
7.015,13*0.,.4,1.,0.,-1.,11*0.,300.,.015,13*0.,50000.,.286,13*0.,50
800.,.5,.5,7.,.05,.8,9*0.,1.,8.,13*0.,1.,8.,.5,.5,11*0.,1.,14*0.,30
9*0./
END

```

```

C*****
C
C FUNCTION STHERM
C -----
C
C PURPOSE
C -----
C   TO COMMUNICATE SINGLE PRECISION CALLS OF WEIGHT ESTIMATING
C   ROUTINES FOR FLUID PROPERTIES WITH THE NNEP ROUTINE -THERM
C   WHICH REQUIPES DOUBLE PRECISION ARGUMENTS
C
C USAGE
C -----
C
C FUNCTION STHERM(I,ARG,FA)
C
C REQUIRED SUBROUTINES
C   THERM
C
C GLCSSARY
C   I      FLAG FOR USAGE
C   ARG    ARGUMENT TO THERM (SINGLE PRECISION)
C   FA     FUEL AIR RATIO (SINGLE PRECISION)
C   DARG   ARGUMENT TO THERM (DOUBLE PRECISION)
C   DFA    FUEL AIR RATIO (DOUBLE PRECISION)
C
C   FUNCTION STHERM (I,ARG,FA)
C   REAL *8DARG,DFA
C   DARG=ARG
C   DFA=FA
C   STHERM=THERM(I,DARG,DFA)
C   RETURN
C   END

```

```

C*****
C
C SUBROUTINE WTEST
C -----
C
C PURPOSE
C -----
C     TO CONTROL THE CALLING OF SUBROUTINES WHICH WILL ESTIMATE THE
C     WEIGHT AND LENGTH OF INDIVIDUAL COMPONENTS
C
C DESCRIPTION
C -----
C     THE OVERALL LENGTH OF THE ENGINE IS CALCULATED BY PROCESSING THE
C     ILENG ARRAY. ALL COMPONENTS EXCEPT DUCTS AND SHAFTS, THEN DUCTS.
C     THE REMAINING COMPONENTS EXCEPT DUCTS AND SHAFTS ARE PROCESSED.
C     THE DUCTS ARE PROCESSED AND FINIALLY THE SHAFTS.
C     A BUILT-IN ASSUMPTION IN THE DUCT ROUTINE IS THAT NO DUCT IS
C     CONNECTED TO ANOTHER DUCT I.E. THE DUCT SIZE IS DETERMINED BY THE
C     ADJOINING COMPONENTS.
C     THEN THE MAXIMUM RADIUS IS FOUND. THEN DEPENDING ON THE PRINT
C     FLAG -IOUTCD- THE REQUIRED PRINTING IS DONE
C     IF THE PLOT CODE FLAG -IPLT- IS TRUE ROUTINE EPLT IS CALLED
C
C USAGE
C -----
C     CALL WTEST
C
C CALLING ROUTINES
C -----
C     FLOCAL-
C     ZTOPZ -
C
C REQUIRED SUBROUTINES
C -----
C     COMP    -COMPRESSOR WEIGHT/LENGTH
C     TURB     -TURBINE
C     SHAFT    -SHAFT
C     DUCTW    -DUCT
C     COMBWT   -PRIMARY BURNER WEIGHT/LENGTH
C     WTNQZ    -NOZZLE      WEIGHT/LENGTH
C     WMIXR    -MIXER
C     WSPLT    -SPLITTER
C     EPLT     -PRINTER/PLOTTER
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DESCRIPTION
C      -----
C      MO/DA/YR  IDENT  NAME          DESCRIPTION OF CHANGES
C
C
C AUTHOR/LANGUAGE/DATE
C -----
C     NORMAN PREWITT-BOEING COMPUTER SERV.  /FORTRAN IV    / OCT 10,1976
C
C GLOSSARY
C -----

```

C	NAME	ORIGIN	USAGE	DESCRIPTION
C	IWMEC	/WMECH/	I	CONTROL INFORMATION
C	WATE	/WMECH/	O	WEIGHT OF EACH COMPONENT
C	ALENG	/WMECH/	O	ACTUAL LENGTH OF EACH COMPONENT
C	TLENG	/WMECH/	O	ACCUMULATED LENGTH TO END OF COMPONENT
C	RI	/WMECH/	O	RADIUS INNER INLET,OUTLET EACH STATION
C	RO	/WMECH/	O	RADIUS OUTER INLET,OUTLET EACH STATION
C	DESVAL	/WMECH/	I	MECHANICAL DESIGN DATA OVERRIDES DEFAULT
C	DSHAF	/WMECH/	O	SHAFT DIAMETER INNER TO OUTER
C	RPMT	/WMECH/	I	ACTUAL COMPONENT RPM
C	IWT	/WMECH/	I	WEIGHT ESTIMATION FLAG TRU=: DO IT
C	IPLT	/WMECH/	I	PLOTTER FLAG TRUE= DO IT
C	IERR	/WMECH/	O	ERROR FLAG
C	ISIO	/WMECH/	I	OUTPUT UNITS 0=ENGLISH, 0 SI
C	ISII	/WMECH/	I	INPUT UNITS 0=ENGLISH, 0 SI
C	IOUTCD	/WMECH/	I	PRINT FLAG 0=SUMMARY, 1=GENERAL,2=DIAGNOSTIC
C	ILENG	/WMECH/	I	COMPONENTS CONTRIBUTING TO OVERALL LENGTH
C	IDID		O	FLAG = 0 COMPONENT NOT YET WEIGHED =1 YES

SUBROUTINE WTEST

```

C          *****
C          * COMMON BLOCKS *
C          *****
COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
2T,DEPV(20),DTOL(20),PERPF(20)
COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
COMMON /CONVER/ CONVER(15)
COMMON /NEOPT/ DEBUG,DEPQ,SELAST,DD,NDSET,NPARTS,ESCALE,NPASSO,NV
1OPT,NJOPT,BOTM,TOPZ

C          *****
C          * DATA STORAGE DEFINITION *
C          *****
REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
LOGICAL PINP,IWT,IPLT,ISIO,ISII
INTEGER IDID(60),ILENG(40)
NAMELIST / W/IWMEC,DESVAL,ACCS,IWT,IPLT,ISII,ISIO,IOUTCD,ILENG

C          *****
C          * DATA STATEMENTS *
C          *****
DATA IDUC,LSHAF,ENGU,SIU,IVALV/4HDUCT,4HSHAF,4HENGL,4HSIU ,4HVALV/
DATA PINP/.TRUE./

C---- TEST WTEST FLAG
C
C      IF (.NOT.IWT) GO TO 420
C

```

```

C---- ZERO CUT OUTPUT ARRAYS
C
DO 10 I=1,5
10 DSHAF(I)=0.
DO 20 I=1,60
WATE(I)=0
NSTAG(I)=0
IDID(I)=0
RPMT(I)=0.
20 ALENG(I)=0
DO 30 I=1,40
TLENG(I)=0
RI(1,I)=0
ILENG(I)=0
RI(2,I)=0
RO(1,I)=0
30 RO(2,I)=0
C
C---- NAMELIST READ OF WTEST DATA
C
CALL NAMEPR (9,10,8,PINP)
READ (8,W)
C
C---- PROCESS LENGTH CONTRIBUTING VECTOR EXCEPT DUCTS AND SHAFTS
C
DO 150 I=1,40
NC=ILENG(I)
IF (NC.EQ.0) GO TO 160
JT=JTYPE(NC)
GO TO (150,70,110,40,50,120,100,60,90,150,150,150,150,150),JT
C---- COMPRESSOR
40 CALL CCMP (NC)
GO TO 140
C---- TURBINE
50 CALL TURB (NC)
GO TO 140
C---- MIXER
60 CALL WMIXR (NC)
GO TO 140
C---- PRIMARY BURNER
70 IF (IWMEC(1,NC).EQ.IDUC) GO TO 80
IF (IWMEC(1,NC).EQ.IVALV) GO TO 130
CALL COMBWT (NC)
GO TO 140
C---- DUCTS
80 CALL DUCTW (NC)
GO TO 140
C---- NOZZLES
90 CALL WTNOZ (NC)
GO TO 140
C---- SPLITTER
100 CALL WSPLT (NC)
GO TO 140
C TRANSFER DIMENSIONS FOR WATER INJECTION
110 CALL DUMMY (NC)
GO TO 140

```



```

C    HEAT EXCHANGER WEIGHT
120  CALL HMEC (NC)
      GO TO 140
C    VALVES
130  CALL VALVWT (NC)
C---- ACCUME LENGTH
140  IUP=JCONF(NC,1)
      IDN=JCONF(NC,3)
      TLENG(IDN)=TLENG(IUP)+ALENG(NC)
      IF (JT.EQ.6) TLENG(IDN)=TLENG(IUP)
      ID2=JCONF(NC,4)
      IF (ID2.GT.0) TLENG(ID2)=TLENG(IUP)+ALENG(NC)
      IF (JT.EQ.6) TLENG(ID2)=TLENG(IUP)
      IU2=JCONF(NC,2)
      IF (IU2.GT.0) TLENG(IU2)=TLENG(IUP)
      IDID(NC)=1
150  CONTINUE
C---- LAST COMPONENT WAS A NOZZLE SET ENGINE MAXIMUM LENGTH
160  ENGLN=TLENG(IDN)
C
C    PROCESS REMAINING COMPONENTS
C
      DO 250 I=1,NCOMP
      IF (IDID(I).EQ.1) GO TO 250
C
C--  PROCESS COMPRESSORS,TURBINES,MIXERS,BURNERS,SPLITTERS
      NC=JTYPE(I)
      IF (NC.LE.0) GO TO 250
      GO TO (250,200,240,170,180,230,220,190,250,250,250,250,250,250),NC
C--  COMPRESSOR
170  CALL COMP (I)
      GO TO 250
C--  TURBINES
180  CALL TURB (I)
      GO TO 250
C--  MIXER
190  CALL WMIXR (I)
      GO TO 250
C--  BURNERS
200  IF (IWMEC(1,I).EQ.IDUC) GO TO 250
      IF (IWMEC(1,I).EQ.IVALV) GO TO 210
      CALL COMBWT (I)
      GO TO 250
C    VALVES
210  CALL VALVWT (I)
      GO TO 250
C--  SPLITTER
220  CALL WSPLT (I)
      GO TO 250
C    HEAT EXCHANGERS
230  CALL HMEC (I)
      GO TO 250
C    TRANSFER DIMENSIONS FOR WATER INJECTION
240  CALL DUMMY (I)
250  CONTINUE
C

```

```

C----- PROCESS DUCTS
DO 260 I=1,NCOMP
IF (IDID(I).EQ.1) GO TO 260
NC=JTYPE(I)
IF (NC.NE.2) GO TO 260
IF (IWMEC(1,I).NE.IDUC) GO TO 260
CALL DUCTW (I)
260 CONTINUE
C----- PROCESS NOZZLES
DO 270 I=1,NCOMP
IF (IDID(I).EQ.1) GO TO 270
NC=JTYPE(I)
IF (NC.NE.9) GO TO 270
CALL WTNOZ (I)
270 CONTINUE
C----- ACCUME LENGTH
DO 290 I=1,NCOMP
IF (IDID(I).EQ.1) GO TO 290
NC=JTYPE(I)
GO TO (290,280,280,280,280,280,280,280,280,290,290,290,290,290),NC
280 IUP=JCONF(I,1)
IU2=JCONF(I,2)
IDN=JCONF(I,3)
ID2=JCONF(I,4)
TLENG(IDN)=TLENG(IUP)+ALENG(I)
IF (NC.EQ.6) TLENG(IDN)=TLENG(IUP)
IF (IU2.GT.0) TLENG(IU2)=TLENG(IUP)
IF (ID2.GT.0) TLENG(ID2)=TLENG(IDN)
IDID(I)=1
290 CONTINUE
C----- PROCESS SHAFTS
DO 310 J=1,5
DO 300 I=1,25
NC=KINDS(11,I)
IF (NC.LE.0) GO TO 310
IF (IWMEC(1,NC).NE.LSHAF) GO TO 300
IF (IWMEC(2,NC).EQ.J) CALL SHAFT (NC)
300 CONTINUE
310 CONTINUE
C
C----- FIND ENGINE MAXIMUM RADIUS
XR=0
DO 330 I=1,NOSTAT
IF (XR.GE.RO(1,I)) GO TO 320
XR=RO(1,I)
320 IF (XR.GE.RO(2,I)) GO TO 330
XR=RO(2,I)
330 CONTINUE
C
C----- GET ENGINE TOTAL WEIGHT AND ALENG CONVERSION
WATENG=0
IF (ACCS.EQ.0) ACCS=.1
WAT=0.
DO 340 I=1,NCOMP
IF (JTYPE(I).EQ.9) GO TO 340
WAT=WATE(I)+WAT

```



```

440  FORMAT (1H1,26H      WEIGHT INPUT DATA IN ,A4,6H UNITS/27H      WEIG
1HT OUTPUT DATA IN ,A4,6H UNITS//)
450  FORMAT (69H      COMP  WT  COMP  ACCU      UPSTREAM RADIUS      DOWNS
1TREAM RADIUS  /77H      NO  EST      LEN      LEN  RI      RO      RI      RO
2  RI      RO      RI      RO      NSTAGE/)
460  FORMAT (/ ,11H      ACCS WT=,F8.3)
470  FORMAT (I7,F6.0,F7.0,F6.0,4F5.0,F6.0,3F5.0,I8)
480  FORMAT (/ ,27H      TOTAL BARE ENGINE WEIGHT=,F6.0,2X,12HACCESSORIES=,F
17.2,2X,23HESTIMATED TOTAL LENGTH=,F6.0,2X,25HESTIMATED MAXIMUM RAD
2IUS=,F5.0)
      END

```

```

C*****
C
C SUBROUTINE NPPNT
C -----
C
C PURPOSE
C -----
C GIVEN X AND Y SCALES, TWO POINTS AND A CHARACTER
C PLOT THAT CHARACTER IN AN ARRAY
C
C USAGE
C -----
C CALL NPPNT(XS,YS,ARRY,CH,P1,P2)
C DIMENSION ARRY(130,54),P1(2),P2(2)
C
C CALLING ROUTINES
C -----
C          DTRAP      - PLOTS A TRAPAZOID
C          ENGPLT     - PLOT CONTROLLER
C
C REQUIRED SUBROUTINES
C -----
C          NONE
C
C MODIFICATION HISTORY
C -----
C          DATE      ID      ANALYST      DESCRIPTION
C          -----
C          MO/DA/YR  IDENT  NAME          REASON FOR CHANGE
C
C AUTHOR/LANGUAGE/DATE
C -----
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLCSSARY
C -----
C          NAME      ORIGIN  USAGE      DESCRIPTION
C          -----
C          ARRY      ARG      0          PLOT SPACE
C          CH        ARG      I          CHARACTER TO PLOT
C          P1        ARG      I          THE X,Y OF THE FIRST POINT
C          P2        ARG      I          THE X,Y OF THE SECOND POINT
C          SUBROUTINE NPPNT (XS,YS,ARRY,CH,P1,P2)
C          DIMENSION ARRY(130,54), P1(2), P2(2)
C
C          FIND MAX AXIS SUBTENDED
C          DX=P2(1)-P1(1)
C          DY=P2(2)-P1(2)
C          IF (ABS(DX).GE..01) DIRX=DX/ABS(DX)
C          IF (ABS(DY).GE..01) DIRY=DY/ABS(DY)
C          XS10=XS*10.
C          YS6=YS*6.
C          INC=0
C          IF (ABS(DY).GT.ABS(DX)) INC=1
C          XI=P1(1)
C          YI=P1(2)

```

```

        IF (ABS(DX).GE..01) SLOPE=DY/DX
C   CALCULATE RASTER LOCATION
10      IXR=XI*XS10
        IYR=54.-YI*YS6
        IXR=MAX0(1,MIN0(130,IXR))
        IYR=MAX0(1,MIN0(54,IYR))
        ARRY(IXR,IYR)=CH
C   INCREMENT ALONG THE LINE
C   CHOOSE X OR Y BASED ON INC
        IF (INC.NE.0) GO TO 20
C   INCREMENT X
        XI=XI+DIRX/XS10
        IF (ABS(DY).LT.0.01) GO TO 30
        YI=(SLOPE*(XI-P1(1))+P1(2))
        GO TO 30
C   INCREMENT Y
20      YI=YI+DIRY/YS6
        IF (ABS(DX).LT.0.01) GO TO 30
        XI=((YI-P1(2))/SLOPE)+P1(1))
C   TEST FOR END POINT
30      IF (INC.NE.0) GO TO 40
        IF (ABS(DX).GT.ABS(XI-P1(1))) GO TO 10
        GO TO 50
40      IF (ABS(DY).GT.ABS(YI-P1(2))) GO TO 10
C   PLOT END POINT
50      IXR=P2(1)*XS10
        IYR=54.-P2(2)*YS6
        IXR=MAX0(1,MIN0(130,IXR))
        IYR=MAX0(1,MIN0(54,IYR))
        ARRY(IXR,IYR)=CH
        RETURN
        END

```

```

C SUBROUTINE DTRAP
C -----
C
C PURPOSE
C -----
C DRAW TRAPAZOID GIVEN START,END,SCALES,RADII,
C AND PLOT CHARACTER
C
C USAGE
C -----
C CALL DTRAP(XS,YS,SI,SE,SII,SIO,SEI,SEO,CH,ARRY)
C DIMENSION(ARRY(130,54))
C
C CALLING ROUTINES
C -----
C     ENGPLT    PLOTTING CONTROLLER
C
C REQUIRED SUBROUTINES
C -----
C     NPPNT     - PLOT A LINE
C
C MODIFICATION HISTORY
C -----
C
C      DATA      ID      ANALYST      DESCRIPTION
C      -----
C      MO/DA/YR   IDENT   NAME          REASON FOR CHANGE
C
C AUTHOR/LANGUAGE/DATA
C -----
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLOSSARY
C -----
C      NAME      OPGIN  USAGE      DESCRIPTION
C      -----
C      XS        ARG    I          X SCALE FACTOR
C      YS        ARG    I          Y SCALE FACTOR
C      SI        ARG    I          X OF FIRST STATION
C      SE        ARG    I          X OF LAST STATION
C      SII       ARG    I          Y OF INSIDE AT FIRST STATION
C      SIO       ARG    I          Y OF OUTER AT FIRST STATION
C      SEI       ARG    I          Y OF INSIDE AT LAST STATION
C      SEO       ARG    I          Y OF OUTER AT LAST STATION
C      CH        ARG    I          CHARACTER TO BE PLOTTED
C      ARRY      ARG    0          PLOT ARRAY
C      SUBROUTINE DTRAP (XS,YS,SI,SE,SII,SIO,SEI,SEO,CH,ARRY)
C
C      DIMENSION ARRY(130,54), P1(2), P2(2), P3(2), P4(2)
C----- SET UP CORNER POINTS
C      P1(1)=SI
C      P1(2)=SII
C      P2(1)=SI
C      P2(2)=SIO
C      P3(1)=SE
C      P3(2)=SEO

```

```
P4(1)=SE  
P4(2)=SEI  
CALL NPPNT (XS,YS,ARRY,CH,P1,P2)  
CALL NPPNT (XS,YS,ARRY,CH,P2,P3)  
CALL NPPNT (XS,YS,ARRY,CH,P3,P4)  
CALL NPPNT (XS,YS,ARRY,CH,P4,P1)  
RETURN  
END
```



```

C SUBROUTINE ENGPLT
C -----
C
C PURPOSE
C -----
C TO MAKE A PRINTER/PLOT OF THE ENGINE COMPONENTS
C
C DESCRIPTION
C -----
C A ARRAY THAT IS 130 (NUMBER OF PRINT COLS) BY
C 54 (NUMBER OF LINES OF PRINT ON ONE PAGE IS SET
C TO BLANK. A SCALE FACTOR IS ESTABLISHED AND THE
C COMPONENTS ARE PLOTTED BY CHANGING THE APPROPRIA
C CHARACTER TO A CHARACTER REPRESENTATIVE OF THE
C COMPONENT IE C FOR COMPRESSOR, B FOR BURNER,
C T FOR TURBINE, D FOR DUCT, N FOR NOZZLE, M FOR
C MIXER,
C
C USAGE
C -----
C      CALL ENGPLT(XL,XR)
C
C CALLING ROUTINES
C -----
C      WTEST  -- THE WEIGHT ESTIMATION ROUTINE
C
C REQUIRED SUBROUTINES
C -----
C      NPPNT  -- PLOT A LINE
C      DTRAP  -- PLOT A TRAPAZOID
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DESCRIPTIO
C      -----
C      MO/DA/YR  IDENT  NAME          REASON FOR
C
C AUTHOR/LANGUAGE/DATE
C -----
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLOSSARY
C -----
C      NAME      ORIGIN  USAGE      DESCRIPTION
C      -----
C      XS              L          X SCALE FACTOR
C      YS              L          Y SCALE FACTOR
C      XL      ARG      I          ENGINE MAX LENGTH
C      XR      ARG      I          ENGINE MAX DIAMETER
C
C SUBROUTINE ENGPLT (XL,XR)
C
C      *****
C      * COMMON BLOCKS *
C      *****

```

```

      REAL *8DATINP,DATOUT,WTF, TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
      IR,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
      2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      1G(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO

C
C
C
C
C
C
      *****
      * DATA STATEMENTS *
      *****

      DIMENSION P1(10), P2(2), ARRY(130,54), CL(4), IDC(5)
      DATA IDC/4HDUCT,4HPBUR,4HDBUR,4HAUG ,4HFMIX/
      DATA CHA,CHB,CHC,CHD,CHM,CHN,CHP,CH1,CHT/1HA,1HB,1HC,1HD,1HM,1HN,1
      1HP,1H),1HT/
      DATA CL/1H-,1HC,1H/,1HL/
      DATA BL/1H /
      DO 10 I=1,130
      DO 10 J=1,54
10    ARRY(I,J)=BL
      XS=13./XL
      YS=9./XR
      XS=AMIN1(XS,YS)
      YS=XS
C----- DRAW A CENTER LINE OF THE ENGINE
C----- THE LINE IS OF THE FORM -----C/L-----C/L-----C/L-----
      I=2
      DO 30 J=1,15
      DO 20 K=1,5
20    ARRY(I,54)=CL(1)
      I=I+1
      ARRY(I,54)=CL(2)
      ARRY(I+1,54)=CL(3)
      ARRY(I+2,54)=CL(4)
30    I=I+3
      DO 40 L=1,8
40    ARRY(I+L,54)=CL(1)
C----- PROCESS EACH COMPONENT
      DO 130 I=1,NCOMP
      IJ1=JCONF(I,1)
      IJ2=JCONF(I,2)
      IJ3=JCONF(I,3)
      JT=JTYPE(I)
      IF (JT.LE.0) GO TO 130
      GO TO (130,50,130,90,100,130,130,110,120,130,130,130,130,130),JT
C----- PROCESS DUCTS,PRIMARY BURNERS,DUCT BURNERS, AND AUGMENTERS

```

```

50    IF (IWMEC(1,I).NE.IDC(1)) GO TO 60
C---- DUCTS
      P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RC(1,IJ1)
      P2(2)=RC(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHD,P1,P2)
      P1(2)=RI(1,IJ1)
      P2(2)=RI(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHD,P1,P2)
      GO TO 130
60    IF (IWMEC(1,I).NE.IDC(2)) GO TO 70
C--- PROCESS PRIMARY BURNERS
      P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RC(2,IJ1)
      P2(2)=RC(1,IJ1)
      CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
      P1(2)=RI(2,IJ1)
      P2(2)=RI(1,IJ1)
      CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
      P1(1)=TLENG(IJ3)
      P1(2)=RI(1,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
      P1(2)=RC(1,IJ3)
      P2(2)=RC(1,IJ1)
      CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
      GO TO 130
70    IF (IWMEC(1,I).NE.IDC(3)) GO TO 80
C--- DRAW DUCT BURNER
      P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RC(1,IJ1)
      P2(2)=RC(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHB,P1,P2)
      P1(2)=RI(1,IJ1)
      P2(2)=RI(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHB,P1,P2)
      P1(1)=P1(1)+.25*(P2(1)-P1(1))
      P2(1)=P1(1)
      P1(2)=RI(1,IJ1)
      P2(2)=RC(1,IJ1)
      CALL NPPNT (XS,YS,ARRY,CH1,P1,P2)
      GO TO 130
80    IF (IWMEC(1,I).NE.IDC(4)) GO TO 130
C--- DRAW AN AUGMENTER
      P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RC(1,IJ1)
      P2(2)=RC(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHA,P1,P2)
      P1(1)=P1(1)+.25*(P2(1)-P1(1))
      P2(1)=P1(1)
      P2(2)=0.
      CALL NPPNT (XS,YS,ARRY,CH1,P1,P2)
      GO TO 130

```

```

C--- DRAW A TRAPZOID FOR A COMPRESSOR
90   CALL DTRAP (XS,YS,TLENG(IJ1),TLENG(IJ3),RI(1,IJ1),RO(1,IJ1),RI(2,I
    1J3),RO(2,IJ3),CHC,ARRAY)
    GO TO 130
C--- DRAW A TRAPAZOID FOR A TURBINE
100  CALL DTRAP (XS,YS,TLENG(IJ1),TLENG(IJ3),RI(1,IJ1),RO(1,IJ1),RI(2,I
    1J3),RO(2,IJ3),CHT,ARRAY)
    GO TO 130
C--- DRAW A MIXER
110  IF (IWMEC(1,I).NE.IDC(5)) GO TO 130
    P1(1)=TLENG(IJ1)
    P2(1)=TLENG(IJ3)
    P1(2)=RI(1,IJ1)
    P2(2)=RI(2,IJ3)
    CALL NPPNT (XS,YS,ARRAY,CHM,P1,P2)
    P1(2)=RO(1,IJ1)
    CALL NPPNT (XS,YS,ARRAY,CHM,P1,P2)
    P1(2)=RI(1,IJ2)
    P2(2)=RO(2,IJ3)
    CALL NPPNT (XS,YS,ARRAY,CHM,P1,P2)
    P1(2)=RO(1,IJ2)
    CALL NPPNT (XS,YS,ARRAY,CHM,P1,P2)
    GO TO 130
C--- DRAW A NOZZLE
120  P1(1)=TLENG(IJ1)
    P2(1)=TLENG(IJ3)
    P1(2)=RO(1,IJ1)
    P2(2)=RO(2,IJ3)
    CALL NPPNT (XS,YS,ARRAY,CHN,P1,P2)
130  CONTINUE
    WRITE (10,140)
    WRITE (10,150) ARRAY
    WRITE (10,140)
    RETURN
C
140  FORMAT (1H1)
150  FORMAT (2X,130A1)
    END

```

```

C SUBROUTINE(DUMMY)
C -----
C
C PURPOSE
C -----
C THIS ROUTINE TRANSFERS DIMENSIONS
C
C
C CALLING ROUTINES
C -----
C
C REQUIRED SUBROUTINES
C -----
C
C MODIFICATION HISTORY
C -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C AUTHOR/LANGUAGE/DATE
C -----
C   E. ONAT , R. J. PERA/FORTRAN IV/ 01 04 77
C
C GLOSSARY
C -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C   ICOMP      ARG      I/O      COMPONENT NUMBER
C
C *****
C
C   SUBROUTINE DUMMY (ICOMP)
C     REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C     1R,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C
C           *****
C           * COMMON BLOCKS *
C           *****
C
C     COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
C     2T,DEPV(20),DTOL(20),PERPF(20)
C     COMMON /SGL/ JF1,JF2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
C     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
C     COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO

```

```

2UTCD,NSTAG(60)
COMMON /CONVER/ CONVER(15)
COMMON /DEFAULT/ DEFAULT(15,20)
LOGICAL IWT,IPLT,IERR,ISII,ISIO
NODEI=JCONF(ICOMP,1)
NODEO=JCONF(ICOMP,3)
WATE(ICOMP)=0.
ALENG(ICOMP)=0.
RO(1,NODEI)=RO(2,NODEI)
RI(1,NODEI)=RI(2,NODEI)
RO(2,NODEO)=RO(2,NODEI)
RI(2,NODEO)=RI(2,NODEI)
RETURN
END

```

C*****

C
C SUBROUTINE(FMEC)
C -----

C
C PURPOSE
C -----

C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF FIXED OR ROTARY HEAT EXCHANGERS.

C
C CALLING ROUTINES
C -----

C
C REQUIRED SUBROUTINES
C -----

C
C DUCT

C
C MODIFICATION HISTORY
C -----

C
C DATE ID ANALYST DISCRIPTION
C -----

C
C
C AUTHOR/LANGUAGE/DATE
C -----
C E. GNAT , R. J. PERA/FORTRAN IV/ 01 04 77

C
C
C GLOSSARY
C -----

C
C
C NAME ORIGIN USAGE DISCRIPTION
C -----

C	ICOMP	ARG	I/O	COMPONENT NUMBER
C	TSCA			MATERIAL SCALER
C	ICES			DESVAL/DEFAULT INDICATOR
C	NODEIP			INLET OF PRIMARY
C	NODEIS			INLET OF SECONDARY
C	NGDEOP			OUTLET OF PRIMARY
C	NODEOS			OUTLET OF SECONDARY
C	TAI			SECONDARY INLET TEMP
C	TAO			SECONDARY EXIT TEMP
C	TEI			PRIMARY INLET TEMP
C	TEO			SECONDARY EXIT TEMP
C	PAI			PRIMARY INLET PRESS
C	PEI			SECONDARY INLET PRESS
C	WAA			SECONDARY AIR FLOW
C	WAE			PRIMARY AIR FLOW
C	FAA			SECONDARY F/A

```

C   FAE                      PRIMARY F/A
C   CNT                      NUMBER OF TUBES
C   AMA                      SECONDARY MACH NUMBER
C   AME                      PRIMARY MACH NUMBER
C   TAAV                     SECONDARY AVERAGE TEMP
C   TEAV                     PRIMARY AVERAGE TEMP
C   AA1                      SECONDARY AREA
C   AE1                      PRIMARY AREA
C   VISA                     SECONDARY FLOW VISCOSITY
C   VISE                     PRIMARY FLOW VISCOSITY
C   REA                      SECONDARY REYNOLDS NUMBER
C   REE                      PRIMARY REYNOLDS NUMBER
C   CKA                      CP*K FOR THE SECONDARY
C   CKE                      CP*K FOR THE PRIMARY
C   DT1                      DELTA TEMP INLET
C   DT2                      DELTA TEMP FOR EXIT
C   AREQ                     REQUIRED AREA
C   HL                       LENGTH
C   R+C                      MATERIAL DENSITY
C   STR                      REFERENCE STRESS
C   WT                       TOTAL WT
C
C *****
C
      SUBROUTINE HMEC (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRD
      1P,TOL,TCLT,TCLTT,DEPV,DTOL,PERPF
C
C          *****
C          * COMMON BLOCKS *
C          *****
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TCLT,TCLT
      2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
      2NCCMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,I0
      2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAULT/ DEFAULT(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C   INITIALIZE INPUTS
C
      IDES=1
      IF (IOUTCD.GT.1) WRITE (10,160) IWMEC(1,ICOMP),ICOMP,IOUTCD
      NODEIP=JCONF(ICOMP,1)
      NODEIS=JCONF(ICOMP,2)
      NODEOP=JCONF(ICOMP,3)
      NODEOS=JCONF(ICOMP,4)
      TAI=TOTEMP(NODEIS)
      TAG=TOTEMP(NODEOS)

```



```

      TEI=TCTEMP(NODEIP)
      TEO=TOTEMP(NODEOP)
      PAI=TOPRES(NODEIS)
      PEI=TOPRES(NODEIP)
      WAA=WTF(NODEIS)
      WAE=WTF(NODEIP)
      FAA=FAR(NODEIS)
      FAE=FAR(NODEIP)

C
C   LOAD DESVAL INPUTS
C
      IF (IWMEC(2,ICOMP).EQ.2) GO TO 40
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (10,20),IDES
10    CNT=DESVAL(1,ICOMP)
      AMA=DESVAL(2,ICOMP)
      AME=DESVAL(3,ICOMP)
      GO TO 30
20    CNT=DEFAUL(1,15)
      AMA=DESVAL(2,15)
      AME=DESVAL(3,15)
30    CONTINUE
C
C   AVERAGE TEMP AND REQUIRED AREA CALCULATIONS
C
      TAAV=(TAI+TAO)*.5
      TEAV=(TEI+TEO)*.5
      AA1=AMA
      AE1=AME
      CALL DUCT (TAAV,PAI,WAA,AA1,FAA,AMA,PSA,VA,ISIO,IP)
      CALL DUCT (TEAV,PEI,WAE,AE1,FAE,AME,PSE,VE,ISIO,IP)
C
C   TUBE AREA AND DIAMETER CALCULATIONS
C
      DIAM=12.*SQRT(4./3.1416*(AA1+AE1))
      AAT=AA1/CNT
      AET=AE1/CNT
      DAT=SQRT(AAT/3.1416*4.)
      DET=SQRT(AET/3.1416*4.)
C
C   FLUID VISCOSITY AND REYNOLDS NUMBER CALCULATIONS
C
      VISA=.02+.0000455*TAAV
      VISE=.02+.0000455*TEAV
      REA=PAI/VISA*VA/53.54*DAT/TAAV*3600.
      REE=PEI/VISE*VE/53.34*DET/TEAV*3600.
      CKA=.000025*TAAV
      CKE=.000025*TEAV
      HA=CKA/DAT*.022*REA**.8
      HE=CKE/DET*.022*REE**.8
C
C   DELTA TEMPERATURE CALCULATIONS FOR PARALLEL AND COUNTER FLOW
C
      DT1=ABS(TEI-TAO)
      DT2=ABS(TEO-TAI)
      IF (IWMEC(3,ICOMP).EQ.1) DT1=ABS(TEI-TAI)

```

```

      IF (IWMEC(3,ICOMP).EQ.1) DT2=ABS(TEO-TAC)
      IF (ABS(DT1-DT2).LT..1) DT1=DT2+.1
      DTM=(DT1-DT2)/ALOG(DT1/DT2)
C
C      REQUIRED Q,TOTAL AREA,LENGTH AND WEIGHT CALCULATIONS
C
      QOA=DTM/(1./HA+1./HE)
      HAO=STHERM(4,TAO,FAA)
      HAI=STHERM(4,TAI,FAA)
      Q=ABS(WAA*(HAO-HAI))
      AREQ=Q/QOA*3600.
      HL=AREQ/3.1416/DAT/CNT
      HL1=HL*12.
      DET1=DET*12.
      DAT1=DAT*12.
      RHO=.168
      STR=50000.
      IF (TAI.GT.1160..OR.TEI.GT.1160.) RHO=.286
      IF (TAI.GT.1160..OR.TEI.GT.1160.) STR=70000.
      THICE=PEI*DET1/2./STR
      THICA=PAI*DIAM/2./STR
      IF (THICE.LT..01) THICE=.01
      IF (THICA.LT..01) THICA=.01
      WT=HL1*3.14159*(DET1*THICE*CNT+DIAM*THICA)*RHO
      WTT=2.*WT
      WATE(ICOMP)=WTT
      ALENG(ICOMP)=HL1
      IF (IOUTCD.NE.2) RETURN
      IF (.NOT.ISIO) GO TO 140
      HL1=HL1*CCNVER(1)
      AREQ=AREQ*CONVER(4)
      DAT1=DAT1*CONVER(1)
      DET1=DET1*CONVER(1)
      WTT=WTT*CONVER(3)
      DIAM=DIAM*CONVER(1)
      VA=VA*CONVER(2)
      VE=VE*CCNVER(2)
      GO TO 140
40    IF (DESVAL(4,ICOMP).EQ.0) IDES=2
      GO TO (50,60),IDES
50    BPR=DESVAL(4,ICOMP)
      GO TO 70
60    BPR=0.
70    CONTINUE
      DELTP=DATOUT(1,ICOMP)
      EFF=DATOUT(4,ICOMP)
      WCP=CORFLO(NODEIP)/1.54972555
      WCS=CORFLO(NODEIS)/1.54972555
      IF (TEI.GE.TAI) WSCA=WCP
      IF (TEI.LT.TAI) WSCA=WCS
      IF (DELTP.GE..1) GO TO 100
      IF (EFF.GE..90) GO TO 90
      IF (EFF.GE..85) GO TO 80
      WTT=(703.8-10.5*BPR)*WSCA/200.
      GO TO 130
80    WTT=(1040.-19.5*BPR)*WSCA/200.

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```

      GO TO 130
90    WTT=(1745.-44.1*BPR)*WSCA/200.
      GO TO 130
100   IF (EFF.GE..90) GO TO 120
      IF (EFF.GE..85) GO TO 110
      WTT=(577.8-16.0*BPR)*WSCA/200.
      GO TO 130
110   WTT=(794.9-19.6*BPR)*WSCA/200.
      GO TO 130
120   WTT=(1275.-27.8*BPR)*WSCA/200.
130   WATE(ICCMP)=WTT
      IF (IOUTCD.NE.2) RETURN
      IF (.NOT.ISIO) GO TO 150
      WTT=WTT*CONVER(3)
      GO TO 150
140   WRITE (10,170)
      WRITE (10,180) HL1,AREQ,DAT1,DET1
      WRITE (10,190)
      WRITE (10,200) XMA,XME,WTT,DIAM
      WRITE (10,210)
      WRITE (10,220) VA,VE,REA,REE,CNT
      RETURN
150   WRITE (10,230)
      WRITE (10,240) WTT
      RETURN

C
160   FORMAT (1H /14H *****/14H *           */4H * ,A4,I3,3H *
1/14H *           */13H *****,I1)
170   FORMAT (32H LENGTH AREA DIM A DIM E)
180   FORMAT (2F8.1,2F8.4,/)
190   FORMAT (30H M A M E WT DIAM)
200   FORMAT (2F8.3,2F8.1,/)
210   FORMAT (39H VA VE RE A RE E TUBES)
220   FORMAT (5F8.0)
230   FORMAT (13H R HEX WEIGHT)
240   FORMAT (F9.1)
      END

```

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C*****
C
C  SUBROUTINE(VLVWT)
C  -----
C
C  PURPOSE
C  -----
C  THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C  OF AIV.
C
C  CALLING ROUTINES
C  -----
C
C  REQUIRED SUBROUTINES
C  -----
C
C    STHERM
C    DLCT1
C
C  MODIFICATION HISTCRY
C  -----
C
C      DATE      ID      ANALYST      DISCRIPTION
C      -----
C
C  AUTHOR/LANGUAGE/DATE
C  -----
C    E. ONAT , R. J. PERA/FORTRAN IV/ 01 04 77
C
C  GLOSSARY
C  -----
C
C      NAME      ORIGIN      USAGE      DISCRIPTION
C      -----
C
C    ICGMP      ARG      I/O      COMPONENT NUMBER
C    TSCA              MATERIAL SCALER
C    IDES              DESVAL/DEFAUL INDICATOR
C    NODEII              INLET OF INNER
C    NODEIO              INLET OF OUTER
C    NCDEOI              OUTLET OF INNER
C    NCDEOO              OUTLET OF OUTER
C    NCOM              OPPOSITE DUCT
C    SPL              SPECIFIC LENGTH
C    PN              NUMBER OF PASSAGES
C    AMI              MACH INNER
C    AMC              MACH OUTER
C    RH              HUB RADIUS INNER
C    RTIC              TIP RADIUS INNER
C    RHOC              HUB RADIUS OUTER
C    RTGC              TIP RADIUS OUTER

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C   WTSI                INNER CYC WT/FT**2
C   WTSQ                OUTER CYC WT/FT**2
C   WTSW                WALL WT/FT**2
C   TTI                TEMPERATURE INNER
C   TTO                TEMPERATURE OUTER
C   PI                 PRESSURE INNER
C   PO                 PRESSURE OUTER
C   WAI                AIRFLOW INNER
C   WAO                AIRFLOW OUTER
C   FAI                FUEL/AIR INNER
C   FAC                FUEL/AIR OUTER
C   GI                 GAMMA INNER
C   GO                 GAMMA OUTER
C   AI                 AREA INNER
C   AC                 AREA OUTER
C   WTIC               INNER CYC WT
C   WTOC               OUTER CYC WT
C   WTWALL             WALL WT
C   WATC               ACTUATOR WT
C   WTOT               TOTAL WT
C   TLENG              LENGTH
C
C *****
C
C   SUBROUTINE VALVWT (ICOMP)
C     REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
C     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C     *****
C     * COMMON BLOCKS *
C     *****
C
C     COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
C     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
C     2T,DEPV(20),DTOL(20),PERPF(20)
C     COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
C     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
C     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
C     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
C     COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
C     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
C     2UTCD,NSTAG(60)
C     COMMON /CONVER/ CONVER(15)
C     COMMON /DEFAULT/ DEFAULT(15,20)
C     LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C   INITIALIZE INPUTS
C
C     IF (IWMEC(3,ICOMP).LT.0) RETURN
C     TSQA=1.
C     IDES=1
C     IF (IOUTCD.GT.1) WRITE (10,100) IWMEC(1,ICOMP),ICOMP,IOUTCD
C     IF (IWMEC(2,ICOMP).EQ.2) GO TO 10
C     NODEII=JCONF(ICOMP,1)
C     NODECI=JCONF(ICOMP,3)
C     NCOM=IWMEC(3,ICOMP)

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      NODEIC=JCONF(NCOM,1)
      NODEOC=JCONF(NCOM,3)
      GO TO 20
10    NODEIC=JCONF(ICOMP,1)
      NODEOC=JCONF(ICOMP,3)
      NCOM=IWMEC(3,ICOMP)
      NODEII=JCONF(NCOM,1)
      NODEIO=JCONF(NCOM,3)
20    IWMEC(3,NCOM)=-ICOMP
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (30,50),IDES
C
C    LOAD DESVAL INPUTS
C
30    SPL=DESVAL(1,ICOMP)
      PN=DESVAL(2,ICOMP)
      AMI=DESVAL(3,ICOMP)
      AMO=DESVAL(4,ICOMP)
      IF (DESVAL(5,ICOMP).EQ.0.) RH=RI(2,NODEII)
      IF (DESVAL(5,ICOMP).GT.0.) RH=DESVAL(5,ICOMP)
      IF (ISII.AND.DESVAL(5,ICOMP).GT.0.) RH=RH/CONVER(1)
      IF (DESVAL(5,ICOMP).LT.0.) IRH=ABS(DESVAL(5,ICOMP))
      IF (DESVAL(5,ICOMP).LT.0.) RH=RI(2,IRH)
      IRHO=1
      IF (DESVAL(6,ICOMP).EQ.0.) IRHO=2
      TTI=TCTEMP(NODEII)
      TTO=TCTEMP(NODEIO)
      IF (IRHO.EQ.2) GO TO 40
      WTSI=DESVAL(6,ICOMP)
      WTSO=DESVAL(7,ICOMP)
      WTSW=DESVAL(8,ICOMP)
      IF (.NOT.ISII) GO TO 70
      WTSI=WTSI/CONVER(7)
      WTSO=WTSO/CONVER(7)
      WTSW=WTSW/CONVER(7)
      GO TO 70
40    WTSI=1.1
      WTSO=1.1
      WTSW=1.1
      IF (TTI.GT.1160..OR.TTO.GT.1160.) TSCA=1.7
      GO TO 70
C
C    LOAD DEFAULT INPUTS
C
50    SPL=DEFAULT(1,17)
      PN=DEFAULT(2,17)
      AMI=DEFAULT(3,17)
      AMO=DEFAULT(4,17)
      IF (DEFAULT(5,17).EQ.0.) RH=RI(2,NODEII)
      IF (DEFAULT(5,17).GT.0.) RH=DEFAULT(5,17)
      IF (ISII.AND.DEFAULT(5,17).GT.0.) RH=RH/CONVER(1)
      IF (DEFAULT(5,17).LT.0.) IRH=ABS(DEFAULT(5,17))
      IF (DEFAULT(5,17).LT.0.) RH=RI(2,IRH)
      IRHO=1
      IF (DEFAULT(6,17).EQ.0.) IRHO=2
      TTI=TCTEMP(NODEII)

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TTC=TCTEMP(NODEIO)
IF (IRHO.EQ.2) GO TO 60
WTSI=DEFAULT(6,17)
WTSO=DEFAULT(7,17)
WTSW=DEFAULT(8,17)
IF (.NOT.ISII) GO TO 70
WTSI=WTSI/CONVER(7)
WTSO=WTSO/CONVER(7)
WTSW=WTSW/CONVER(7)
GO TO 70
60  WTSI=1.1
    WTSO=1.1
    WTSW=1.1
    IF (TTI.GT.1160..OR.TTO.GT.1160.) TSCA=1.7

C
C
C
70  PIE=3.1415926
    WAI=WTF(NODEII)
    WAO=WTF(NODEIO)
    PI=TOPRES(NODEII)*144.
    PO=TOPRES(NODEIO)*144.
    FAI=FAR(NODEII)
    FAC=FAR(NODEIO)
    GI=STHERM(5,TTI,FAI)
    GO=STHERM(5,TTO,FAC)
    AI=0.
    AO=0.
    CALL DUCT1 (TTI,PI,WAI,GI,AMI,AI)
    CALL DUCT1 (TTO,PO,WAO,GO,AMO,AO)
    AA=(AO+AI)/2.

C
C
C
    DETERMINE VALVE DIMENSIONS AND WEIGHTS

    RTIC=SQRT(AI/PIE*144.+RH**2)
    RHOC=RTIC
    RTOC=SQRT(AO/PIE*144.+RHOC**2)
    VLENG=SPL*SQRT(4.*AA/PIE*144.)
    RMEAN=SQRT(AA/PIE*144.+RH**2)
    WTIC=2.*PIE*RH*VLENG*WTSI/144.*TSCA
    WTOC=2.*PIE*RTOC*VLENG*WTSO/144.*TSCA
    WTWALL=(3.927*RMEAN+1.25*PN*(ROTC-RH))*VLENG*WTSW/144.*TSCA
    WTOT=WTIC+WTOC+WTWALL
    WACT=0.
    IF (IWMEC(4,ICOMP).EQ.0) GO TO 80
    WACT=.1*WTOT
    IF (WACT.LT.10.) WACT=10.
    IF (WACT.GT.40.) WACT=40.
    WTOT=WTOT+WACT

C
C
C
80  WATE(ICOMP)=WTOT/2.
    WATE(NCCM)=WTOT/2.
    ALENG(ICOMP)=VLENG
    ALENG(NCOM)=VLENG

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      RI(1,NODEII)=RH
      RO(1,NODEII)=RTIC
      RI(1,NODEIO)=RHIC
      RO(1,NODEIO)=RTOC
      RI(2,NODEOI)=RH
      RO(2,NODEOI)=RTIC
      RI(2,NODEOO)=RHOC
      RO(2,NODEOO)=RTOC
      IF (IOUTCD.LE.1) RETURN

C
C   WRITE OUTPUT
C
      IF (.NOT.ISIO) GO TO 90
      RH=RH*CCNVER(1)
      RTIC=RTIC*CONVER(1)
      RHCC=RHCC*CONVER(1)
      RTOC=RTCC*CONVER(1)
      VLENG=VLENG*CONVER(1)
      AI=AI*CCNVER(4)
      AO=AO*CONVER(4)
      RMEAN=RMEAN*CONVER(1)
      WTIC=WTIC*CONVER(3)
      WTOC=WTCC*CONVER(3)
      WTWALL=WTWALL*CONVER(3)
      WACT=WACT*CONVER(3)
      WTCT=WTCT*CONVER(3)
90   WRITE (10,110) RH,RTIC,RHOC,PTOC,VLENG,AI,AO,RMEAN
      WRITE (10,120) WTIC,WTOT,WTWALL,WACT,WTOT
      RETURN

C
100  FORMAT (1H /14H *****/14H *                */4H * ,A4,I3,3H *
1/14H *                */13H *****,I1)
110  FORMAT (/ ,6H RHUB=,2X,F6.2,5X,6H RTIP=,2X,F6.2,5X,7H RHOUT=,1X,F6.
12,/,7H RTCUT=,1X,F6.2,5X,6H LENG=,2X,F6.2,5X,7H AREAI=,1X,F6.1,/,7
2H AREAO=,1X,F6.1,5X,7H RMEAN=,1X,F6.2)
120  FORMAT (/ ,13H WT INNER CYC,3X,F6.1,5X,12HWT OUTER CYL,3X,F6.1,/,12
1H WT OF WALLS,3X,F6.1,5X,10H WT OF ACT,5X,F6.1,/,15H TOTAL VALVE W
2T,3X,F6.1)
      END

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